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am the translator of the documents attached and I state that the following is a true translation to the best of my knowledge and belief.

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[List of the Attached Documents]

[Name of the Document]	Specification	1
[Name of the Document]	Drawings	1
[Name of the Document]	Abstract	1

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SPECIFICATION

[TITLE OF THE INVENTION]

OPTICAL MULTI-DISTRIBUTION COMMUNICATION SYSTEM

[SCOPE OF THE PATENT CLAIMS]

[Claim 1] An optical multi-distribution communication system in which a parent station side unit is connected to a plurality of child station side units via a first optical network and a second optical network, comprising:

bandwidth control means for apportioning the plurality of child station side units to the first optical network and the second optical network, for allocating a predetermined transmission bandwidth to each of the plurality of child station side units, and for accepting a bandwidth change of the transmission bandwidth.

[Claim 2] An optical multi-distribution communication system according to claim 1, wherein when a failure occurs in one of the first optical network and the second optical network, the bandwidth control means allocates all transmission bandwidths of the child station side units to the other optical network.

[Claim 3] An optical multi-distribution communication system according to claim 1, wherein when a failure occurs in a working side child station side unit of the plurality of child station side units, the bandwidth control means switches the working side child station side unit to a standby side, and switches a standby side child station side unit to the working side.

[Claim 4] An optical multi-distribution communication system according to claim 3, wherein when apportionment balance is lost of the plurality of child station side units between the first optical network and the second optical network, the bandwidth control means carries out apportionment of the plurality of child station side units between the first optical network and the second optical network, again.

[Claim 5] An optical multi-distribution communication system according to claim 1, wherein the bandwidth control means allocates a minimum guarantee bandwidth to the plurality of child station side units.

[Claim 6] An optical multi-distribution communication system according to claim 5, wherein the bandwidth control means apportions the plurality of child station side units to one of the first optical

network and the second optical network such that a sum total of minimum guarantee bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of minimum guarantee bandwidths of each of the child station side units in the second optical network.

[Claim 7] An optical multi-distribution communication system according to claim 5, wherein the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of maximum bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of maximum bandwidths of each of the child station side units in the second optical network.

[Claim 8] An optical multi-distribution communication system according to claim 5, wherein the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of each of the child station side units in the second optical network.

[Claim 9] An optical multi-distribution communication system according to claim 5, wherein the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of established bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of established bandwidths of each of the child station side units in the second optical network.

[Claim 10] An optical multi-distribution communication system in which a parent station side unit is connected to a plurality of child station side units via a first optical network and a second optical network, comprising:

bandwidth control means for apportioning a plurality of paths contained in the plurality of child station side units to the first optical network and the second optical network, for allocating a predetermined transmission bandwidth to each of the path, and for accepting a bandwidth change of the transmission bandwidth.

[Claim 11] An optical multi-distribution communication system according to claim 10, wherein when a failure occurs in one of the first optical network and the second optical network, the bandwidth control means allocates all the paths contained in the plurality of child station side units to the other optical network.

[Claim 12] An optical multi-distribution communication system according to claim 10, wherein when a failure occurs in a working side path of the plurality of paths, the bandwidth control means switches the path to a standby side, and switches a standby side path to the working side.

[Claim 13] An optical multi-distribution communication system according to claim 12, wherein when apportionment balance is lost of the plurality of paths between the first optical network and the second optical network, the bandwidth control means carries out apportionment of the plurality of paths between the first optical network and the second optical network, again.

[Claim 14] An optical multi-distribution communication system according to claim 10, wherein the bandwidth control means allocates a minimum guarantee bandwidth to the plurality of paths.

[Claim 15] An optical multi-distribution communication system according to claim 14, wherein the bandwidth control means apportions the plurality of paths to one of the first optical network and the second optical network such that a sum total of minimum guarantee bandwidths of the paths in the first optical network becomes nearly equal to a sum total of minimum guarantee bandwidths of the paths in the second optical network.

[Claim 16] An optical multi-distribution communication system according to claim 14, wherein the bandwidth control means apportions the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of maximum bandwidths of the paths in the first optical network becomes nearly equal to a sum total of maximum bandwidths of the paths in the second optical network.

[Claim 17] An optical multi-distribution communication system according to claim 14, wherein the bandwidth control means apportions the plurality of paths to one of the first optical network and the second optical network such that a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of the paths in the first optical network becomes nearly equal to a sum total of

differences between maximum bandwidths and minimum guarantee bandwidths of the paths in the second optical network.

[Claim 18] An optical multi-distribution communication system according to claim 14, wherein the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of established bandwidths of the paths in the first optical network becomes nearly equal to a sum total of established bandwidths of the paths in the second optical network.

[DETAILED DESCRIPTION OF THE INVENTION]

[Technical Field of the Invention]

The present invention relates to an optical multi-distribution communication system for operating DBA (Dynamic Bandwidth Allocation) in a duplex optical distribution section such as a PDS (Passive Double Star) section.

[Prior Art]

A conventional optical multi-distribution communication system is disclosed in Japanese patent application laid-open No. 11-122172/1999, or specified in ITU-T (International Telecommunication Union-Telecommunication) Recommendation G.983.1, for example.

Fig. 11 is a diagram showing a conventional optical multi-distribution communication system defined in ITU-T Recommendation G.983.1. In this figure, the reference numeral 1 designates a parent station side unit, reference numerals 2-1 - 2-n each designate a child station side unit, and 3 designates an optical splitter.

Next, the operation will be described.

In the ITU-T Recommendation G.983.1, a downstream optical signal from the parent station side unit 1 is split by the optical splitter 3 to be broadcast to the child station side units 2-1 - 2-n.

On the other hand, upstream signals from the child station side units 2-1 - 2-n are multiplexed by the optical splitter 3 to be transmitted to the parent station side unit 1. In the course of this, to multiplex the upstream signals from the child station side units 2-1 - 2-n, access control (delay control) is carried out on the optical splitter 3. The delay control is also described in the ITU-T Recommendation G.983.1.

Fig. 12 is a block diagram showing a detailed configuration of the optical multi-distribution communication system of Fig. 11. In this figure, the reference numeral 11 designates a delay measurement

cell generating section, 12 designates an OAM (Operation Administration and Maintenance) cell inserting section, 13 designates a transmitting/receiving section, 14 designates a state controlling section, 15 designates an OAM cell demultiplexing section, 16 designates a delay amount measuring section, 17 designates a delay amount correcting section, 21 designates a transmitting/receiving section, 22 designates a frame synchronizing section, 23 designates an OAM cell demultiplexing section, 24 designates a delay amount setting section, 25 designates a buffer memory, 26 designates a state controlling section, and 27 designates an OAM cell inserting section.

The optical multi-distribution communication system as shown in Fig. 12 carries out a sequence called ranging at power-up.

The ranging is carried out as follows. First, in the parent station side unit 1, the delay measurement cell generating section 11 generates delay measurement cells for particular child station side units 2-1 - 2-n.

The delay measurement cells generated by the delay measurement cell generating section 11 are each multiplexed into downstream main data as an OAM cell by the OAM cell inserting section 12 to be transmitted to the child station side units 2-1 - 2-n through the transmitting/receiving section 13 including an optical transceiver and a WDM (Wavelength Division Multiplexing) coupler.

Each of the child station side units 2-1 - 2-n converts the received optical signal to an electric signal by the transmitting/receiving section 21 including an optical transceiver and a WDM coupler.

This electric signal is fed to the frame synchronizing section 22 that regularly inserts frame synchronization bits into OAM cells, which enable the frame synchronization to be established and the cell delimiter of each cell to be identified.

For example, the OAM cell demultiplexing section 23 of the child station side unit 2-1 identifies incoming data cells and OAM cells, and separates them. The delay amount setting section 24, recognizing the delay measurement cell in the isolated OAM cells, immediately notifies the OAM cell inserting section 27 of it to transmit a delay measurement cell as a response to the parent station side unit 1 via the transmitting/receiving section 21 and the optical splitter 3. Thus, receiving the delay measurement cell, the child station side unit 2-1 sends the response immediately back to the parent station

side unit 1.

On the other hand, the OAM cell demultiplexing section 15 of the parent station side unit 1 separates the OAM cells from the data cell.

The delay amount measuring section 16, detecting the delay amount measurement cell in the OAM cells separated by the OAM cell demultiplexing section 15, measures a round-trip delay by the response of the delay measurement cell. The round-trip delay is a time period between the transmission and reception of the cell by the parent station side unit 1, during which the cell is transmitted to the child station side unit 2-1 via the optical splitter 3, and is sent back to the parent station side unit 1.

The delay measurement cell generating section 11 computes the delay between the parent station side unit 1 and the child station side unit 2-1 from the round-trip delay, generates a delay measurement value information cell including information about the delay, and supplies it to the OAM cell inserting section 12. The OAM cell inserting section 12 inserts the delay measurement value information cell to an OAM cell to be transmitted to the child station side unit 2-1 by the transmitting/receiving section 13.

Receiving the cell including the delay measurement value information cell, the OAM cell demultiplexing section 23 of the child station side unit 2-1 isolates the OAM cell. When the OAM cell includes the delay measurement value information cell, the delay amount setting section 24 sets the delay amount as a control quantity of read-out time for the buffer memory 25. Thus, the multiple child station side units can each set the transmission timing to the parent station side unit 1 considering the delay time, so that the multiplexing can be performed in order, and the upstream optical transmission is carried out normally. The state controlling sections 14 and 26 make a decision that the party is in an operating state when the cell is sent back within the normal round-trip delay, followed by measuring the delay amount of the upstream cell, by fine adjustment of the delay amount of the cell by the delay amount correcting section 17, whereas when the cell is not sent back within the normal round-trip delay, they make a decision that the party is in an abnormal condition.

The ITU-T Recommendation G.983.1 also defines a duplex optical multi-distribution communication system as shown in Fig. 13, which completely doubles the parent station side units, the child station side units and the components between them. The duplex optical

multi-distribution communication system comprises instead of the parent station side unit 1 as shown in Fig. 11, a parent station side unit 1a as an working side and a parent station side unit 1b as a standby side, which are connected to the optical splitters 3. In addition, instead of the child station side units 2-1 - 2-n as shown in Fig. 11, it comprises child station side units 2-1a - 2-na as the working side, and child station side unit 2-1b - 2-nb as the standby side, which are connected to the optical splitters 3.

Then, optical fibers interconnect the optical splitters 3 with the parent station side units 1a and 1b, and the optical splitters 3 with the child station side units 2-1a - 2-na and 2-1b - 2-nb.

The duplex optical multi-distribution communication system sometimes uses a technique called DBA (Dynamic Bandwidth Allocation) that operates as follows.

Fig. 14 is a diagram illustrating an outline of the bandwidth allocation by the DBA.

As for each of the child station side units 2-1a - 2-na, a minimum guarantee bandwidth (an available traffic bandwidth without exception) and a maximum bandwidth (a traffic bandwidth of a maximum possible transmission which is not necessarily assured) are set by contract.

When a 0-system is the working side, the sum total of the minimum guarantee bandwidths of the child station side units 2-1a - 2-na are secured on the 0-system transmission line without fail. A DBA usable bandwidth (the total transmission capacity - the sum total of the minimum guarantee bandwidths of the child station side units) as shown in Fig. 14 can be used in common by the child station side units 2-1a - 2-na.

If an upstream cell bandwidth from the child station side unit is about to exceed the established bandwidth (equals the minimum guarantee bandwidth here), a bandwidth monitor in the parent station side unit 1a installed for each of the child station side units 2-1a - 2-na detects it. For example, the bandwidth monitor measures the bandwidth of the cells by counting the number of incoming cells in a fixed time period, which are transmitted from each of the child station side units 2-1a - 2-na to the parent station side unit.

Then, the parent station side unit 1a increases the bandwidth of the child station side unit within the DBA usable bandwidth in such a way that the parent station side unit 1a notifies the child

station side units 2-1a - 2-na of the reallocated bandwidth so that the child station side units 2-1a - 2-na can change the transmission traffic bandwidth. This enables the parent station side unit 1a to dynamically allocate additional bandwidths to some child station side units 2-1a - 2-na that require a bandwidth greater than the minimum guarantee bandwidth.

When the child station side units 2-1a - 2-na that are assigned the additional bandwidths are congested, the congested child station side units apportion the bandwidths among them within the DBA usable bandwidth.

Thus, in the event of the congestion, not all the congested child station side units can secure a sufficient bandwidth because the sum total of the maximum bandwidths of the child station side units 2-1a - 2-na would exceed the total transmission capacity in such a case.

In contrast, when a particular child station side unit decreases its upstream cell bandwidth below the increased bandwidth, it can be reduced with ensuring the minimum guarantee bandwidth.

[Problems to be Solved by the Invention]

With the foregoing configuration where the parent station side units and the child station side units are duplexed (referred to Fig. 13), the conventional optical multi-distribution communication system secures the transmission bandwidths of all the child station side units 2-1 - 2-n within the bandwidth of the 0-system parent station side unit 1a (when the 0-system is the working side) at the start-up of the system. Accordingly, the maximum additional bandwidth available by the DBA equals the total transmission bandwidth minus the sum total of the minimum guarantee bandwidths of the child station side units 2-1a - 2-na. This presents a problem of being unable to secure a large DBA usable bandwidth when the child station side units 2-1a - 2-na congest because of increasing bandwidths (because the bandwidth of the 1-system remains unused).

The present invention is implemented to solve the foregoing problem. It is therefore an object of the present invention to provide an optical multi-distribution communication system enabling child station side units to secure a large DBA usable bandwidth in the DBA operation.

[Means for Solving the Problems]

According to an optical multi-distribution communication system, the plurality of child station side units are apportioned to the first

optical network and the second optical network, for allocating a predetermined transmission bandwidth to each of the plurality of child station side units, and for accepting a bandwidth change of the transmission bandwidth.

According to an optical multi-distribution communication system, when a failure occurs in one of the first optical network and the second optical network, the bandwidth control means allocates all transmission bandwidths of the child station side units to the other optical network.

According to an optical multi-distribution communication system, when a failure occurs in a working side child station side unit of the plurality of child station side units, the bandwidth control means switches the working side child station side unit to a standby side, and switches a standby side child station side unit to the working side.

According to an optical multi-distribution communication system, when apportionment balance is lost of the plurality of child station side units between the first optical network and the second optical network, the bandwidth control means carries out apportionment of the plurality of child station side units between the first optical network and the second optical network, again.

According to an optical multi-distribution communication system, the bandwidth control means allocates a minimum guarantee bandwidth to the plurality of child station side units.

According to an optical multi-distribution communication system, the bandwidth control means apportions the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of minimum guarantee bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of minimum guarantee bandwidths of each of the child station side units in the second optical network.

According to an optical multi-distribution communication system, the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of maximum bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of maximum bandwidths of each of the child station side units in the second optical network.

According to an optical multi-distribution communication system,

the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of each of the child station side units in the second optical network.

According to an optical multi-distribution communication system, the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of established bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of established bandwidths of each of the child station side units in the second optical network.

According to an optical multi-distribution communication system, a plurality of paths contained in the plurality of child station side units is apportioned to the first optical network and the second optical network, for allocating a predetermined transmission bandwidth to each of the path, and for accepting a bandwidth change of the transmission bandwidth.

According to an optical multi-distribution communication system, when a failure occurs in one of the first optical network and the second optical network, the bandwidth control means allocates all the paths contained in the plurality of child station side units to the other optical network.

According to an optical multi-distribution communication system, when a failure occurs in a working side path of the plurality of paths, the bandwidth control means switches the path to a standby side, and switches a standby side path to the working side.

According to an optical multi-distribution communication system, when apportionment balance is lost of the plurality of paths between the first optical network and the second optical network, the bandwidth control means carries out apportionment of the plurality of paths between the first optical network and the second optical network, again.

According to an optical multi-distribution communication system, the bandwidth control means allocates a minimum guarantee bandwidth to the plurality of paths.

According to an optical multi-distribution communication system, the bandwidth control means apportions the plurality of paths to one of the first optical network and the second optical network such that a sum total of minimum guarantee bandwidths of the paths in the first optical network becomes nearly equal to a sum total of minimum guarantee bandwidths of the paths in the second optical network.

According to an optical multi-distribution communication system, the bandwidth control means apportions the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of maximum bandwidths of the paths in the first optical network becomes nearly equal to a sum total of maximum bandwidths of the paths in the second optical network.

According to an optical multi-distribution communication system, the bandwidth control means apportions the plurality of paths to one of the first optical network and the second optical network such that a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of the paths in the first optical network becomes nearly equal to a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of the paths in the second optical network.

According to an optical multi-distribution communication system, the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of established bandwidths of the paths in the first optical network becomes nearly equal to a sum total of established bandwidths of the paths in the second optical network.

[Embodiment of the Invention]

An embodiment of the present invention is described below.

EMBODIMENT 1

First, a branch switching configuration will be outlined which is one of the duplex switching systems constituting a basic configuration of the present embodiment 1. Fig. 4 is a block diagram showing a configuration of a duplex optical distribution system that carries out the branch switching. In this figure, the reference numeral 100 designates a parent station side unit, 101 designates a child station side unit, 102 designates an optical coupler, 111 designates a 0/1-system selecting section, 112 designates an SEL, 113 designates a route setting section, 114a designates a PDS-IF(0)

as a PDS interface, 114b designates a PDS-IF(1) as a PDS interface, 115 designates a system selection signal generating section, 116a designates a 0-system signal termination, 116b designates a 1-system signal termination, 117 designates a system selection signal generating section, 118 designates a 2-1 SEL, 119 designates a route setting section, 120-1 - 120-n each designate an LIM (Line Interface Module, which is a detachable/attachable interface card for each service).

Next, the operation will be described.

In the branch switching, the parent station side unit 100 switches the child station side units one by one independently (in contrast to the branch switching, there is a configuration called tree switching in which the parent station side unit switches all the child station side units to the 0-system or to the 1-system at once). Thus, in the branching switching, it is not unlikely that a particular child station side unit uses the 0-system transmission line as the working side, but another child station side unit employs the 1-system transmission line as the working side.

In Fig. 4, the child station side unit 101 and the parent station side unit 100 are connected through the optical couplers 102. In the child station side unit 101, the optical couplers 102 are connected to the 0-system signal termination 116a and the 1-system signal termination 116b via optical fibers, respectively, to process downstream signals sent from the parent station side unit 100, thereby providing n signals with separate services associated with the n LIMs, (n is the number of the LIMs).

In addition, the 0-system signal termination 116a and the 1-system signal termination 116b each extract system selection information on the 0/1-system transmission lines from the OAM cell of the downstream signals, and transmit to the parent station side unit 100 an upstream signal into which n signals, each of which is associated with one of n LIMs, are multiplexed.

The system selection signal generating section 117 receives the system selection information on the 0/1-system transmission lines from the 0-system signal termination 116a and 1-system signal termination 116b, and supplies it to the 2-1 SEL 118 for selecting downstream signals, and to the upstream route setting section 119.

The 2-1 SEL 118 for selecting the downstream signals selects one of two sets of n signals supplied from the 0-system signal termination

116a and 1-system signal termination 116b in response to the selection information fed from the system selection signal generating section 117, and transmits the selected signals to the corresponding LIMs.

The route setting section 119 routes a set of n upstream signals LIM1 - LIMn to either the 0-system signal termination 116a or 1-system signal termination 116b in response to the system selection information fed from the system selection signal generating section 117.

The PDS-IF(0) 114a and PDS-IF(1) 114b of the parent station side unit 100 are connected to the optical couplers 102 through optical fibers.

The system selection signal generating section 115 generates system selection information from information about a fault of the transmission line or the like (for example, if a transmission line failure of the 0-system is detected in a particular child station side unit, and when the 1-system transmission line is normal, the system selection signal generating section 115 generates the system selection information to switch the child station side unit to the 1-system, or vice versa), then supplies the system selection information to the upstream signal SEL 112 and to the downstream route setting section 113.

The SEL 112 selects one of the signals supplied from the PDS-IF(0) 114a and PDS-IF(1) 114b on one-by-one basis of the child station side units in response to the system selection information on the 0/1-system transmission line fed from the system selection signal generating section 115 (the system selection information is multiplexed into each cell).

The route setting section 113 routes the incoming signal to one of the PDS-IF(0) 114a and PDS-IF(1) 114b on a one-by-one basis of the child station side units in response to the system selection information fed from the system selection signal generating section 115.

Next, a concrete operation will be described taking an example where two child station side units #1 and #2 are connected to the parent station side unit 100.

Assume that the child station side unit #1 uses the 0-system as the working side, and the child station side unit #2 employs the 1-system as the working side. In this case, in the child station side unit #1, the system selection signal generating section 117 extracts

the system selection information for selecting the 0-system from the downstream signals (OAM cells), and supplies it to the 2-1 SEL 118 and route setting section 119, so that the upstream signals are sent to the 0-system, and the downstream signals are selected from the 0-system.

In the child station side unit #2, the system selection signal generating section 117 extracts the system selection information for selecting the 1-system from the downstream signals (OAM cells), and supplies it to the 2-1 SEL 118 and route setting section 119, so that the upstream signals are sent to the 1-system side, and the downstream signals are selected from the 1-system side.

As for the downstream processing of the parent station side unit 100, the route setting section 113 identifies the cells to be sent from the child station side units using child station side unit numbers assigned to individual child station side units, for example, and selects one of the 0-system and 1-system in response to the system selection information on each child station side unit fed from the system selection signal generating section 115. As for the upstream processing, the SEL 112 identifies the cells sent from the child station side units using the child station side unit numbers assigned to individual child station side units, for example, and selects one of the 0-system and 1-system signals in response to the system selection information on each child station side unit fed from the system selection signal generating section 115, thereby carrying out the signal switching (multiplexing) between the 0-system and 1-system for each child station side unit independently. Thus, the switching on a one-by-one basis of the child station side units is carried out (on a one-by-one basis of the child station side unit numbers corresponding to the child station side unit, in this example).

Fig. 3 is a schematic diagram illustrating an outline of a dynamic bandwidth allocation method in the duplex PDS configuration. Referring to this figure, the concept of the dynamic bandwidth allocation method will be described. In contrast to the conventional example of Fig. 14, the branch switching of the present embodiment 1 can utilize both the 0-system transmission line and 1-system transmission line as the working side. Thus, when starting the system or adding new child station side units, a setting is made such that some child station side units employ the 0-system as the working side child station side units (referred to as a child station side unit

working on 0-system), and other child station side units employ the 1-system as the working side child station side units (referred to as a child station side unit working on the 1-system).

The bandwidth allocation is made as follows: a minimum transmission bandwidth is assigned to each child station side unit independently in either the 0-system or the 1-system when the two systems are normal, and the remaining bandwidth in both the systems is reserved as a dynamic allocation bandwidth so that when one of the two systems falls into a failure in any of the child station side units, their transmission bandwidths are secured dynamically in the dynamic allocation bandwidth of the normal system. For example, as illustrated in Fig. 3, when both the systems are normal, the child station side units are apportioned between the 0-system and 1-system such that the sum total of the minimum guarantee bandwidths of the m child station side units working on the 0-system becomes nearly equal to that of the l child station side units working on the 1-system, (m + l is the total number of the child station side units). In this way, the 1-system bandwidth becomes available as the DBA bandwidth. This makes it possible to utilize the bandwidth effectively, and to increase the maximum bandwidth of the DBA available by all the child station side units in common.

Fig. 1 is a block diagram showing a configuration for implementing the dynamic bandwidth allocation control method in the duplex PDS configuration. In this figure, the reference numeral 200 designates a bandwidth controlling section (bandwidth control means) for the child station side units; 201 designates a 0/1-system apportioning controlling section for the child station side units; 202 designates a bandwidth allocation controlling section for the child station side units using the 0-system; 203 designates a bandwidth allocation controlling section for the child station side units using the 1-system; 204 designates a 0-system PDS processing section; and 205 designates a 1-system PDS processing section.

Fig. 2 is a block diagram showing a detailed configuration of the PDS processing section as shown in Fig. 1. In this figure, the reference numeral 211 designates a transmitting/receiving section, 212 designates an OAM cell demultiplexing section, 213 designates a state controlling section, 214 designates a delay amount measuring section, 215 designates a delay amount correcting section, 216 designates a delay measurement cell generating section, 217

designates a bandwidth monitor for the child station side units, 218 designates a grant generating section, 219 designates a 0/1-system selection information generating section, 220 designates an OAM cell generating section, 221 designates an OAM cell inserting section, and 222 designates a 0/1-system selection information inserting section.

The 0/1-system apportioning controlling section 201 for the child station side units divides all the child station side units connected to the parent station side unit to the child station side units working on 0-system and the child station side units working on the 1-system, when starting the duplex distribution network system or adding new child station side units. Specifically, the bandwidth allocation is made as follows: First, a minimum transmission bandwidth is assigned to each child station side unit independently in either the 0-system or 1-system when the two systems are normal; and second, the remaining bandwidth is reserved as a dynamic allocation bandwidth so that when one of the two systems fails in any of the child station side units, their transmission bandwidths are secured dynamically in the dynamic allocation bandwidth of the normal system.

For example, the division of the child station side units to the 0/1-system is made such that the sum total of the minimum guarantee bandwidths WLi (i is an arbitrary number from one to n) that are specified by the contract of the m child station side units working on the 0-system becomes nearly equal to the sum total of the minimum guarantee bandwidths WLj (j is an arbitrary number from one to n) that are specified by the contract of the l child station side units working on the 1-system, where m + l is the total number of the child station side units. Thus, as for the DBA bandwidth, the 0-system can secure the bandwidth equal to the maximum available bandwidth of the transmission line - (the sum total of the minimum guarantee bandwidths WLi), and the 1-system can secure the bandwidth equal to the maximum available bandwidth of the transmission line - (the sum total of the minimum guarantee bandwidths WLj). This makes it possible for the DBA to utilize the 1-system bandwidth, enabling the effective use of the bandwidth.

Furthermore, the 0/1-system apportioning controlling section 201 assigns a maximum bandwidth to each child station side unit, and supplies child station side unit numbers for identifying the child station side units and the set values of the minimum guarantee

bandwidths and maximum bandwidths to the bandwidth allocation controlling section 202 for the child station side units using the 0-system and to the bandwidth allocation controlling section 203 for the child station side units using the 1-system.

The bandwidth allocation controlling section 202 for the child station side units using the 0-system receives the child station side unit numbers together with the set values of the minimum guarantee bandwidths and maximum bandwidths from the 0/1-system apportioning controlling section 201 for the child station side units, and carries out the DBA processing in response to the information. More specifically, in the normal operation, the bandwidth allocation controlling section 202 for the child station side units using the 0-system determines the bandwidth to be allocated to each child station side unit as follows from its child station side unit number and its minimum guarantee bandwidth and maximum bandwidth fed from the 0/1-system apportioning controlling section 201 for the child station side units. The bandwidth allocation controlling section 202 determines the bandwidth of each child station side unit such that its established bandwidth (value that greater than the minimum guarantee bandwidth and equal to or less than the maximum bandwidth, and the sum total of the bandwidths assigned to the child station side units does not exceed the maximum available bandwidth). Then, it notifies the 0-system PDS processing section 204 of the established bandwidths of the individual child station side units, and of the 0/1-system selection information notification indicating as to whether the 0-system or 1-system is selected by the child station side units.

The 0-system PDS processing section 204 generates a bandwidth change notification for each child station side unit (when it detects that the cell bandwidth received from the child station side unit is greater or less than a predetermined threshold value, and supplies it to the bandwidth allocation controlling section 202 for the child station side units using the 0-system). Receiving the bandwidth change notification of each child station side unit from the 0-system PDS processing section 204, the bandwidth allocation controlling section 202 for the child station side units using the 0-system increases the established bandwidth of the child station side unit, when the notification indicates a bandwidth greater than the threshold value, and the DBA usable bandwidth is available. On the other hand,

if the bandwidth is less than the threshold value, it can reduce the established bandwidth of the child station side unit. Here, the threshold value can take multiple values.

Receiving the bandwidth change notifications about a plurality of the child station side units, from which the cell bandwidths greater than the threshold value are received, it increases the established bandwidths of all the corresponding child station side units as long as the DBA usable bandwidth is available. In contrast, when the DBA usable bandwidth has only a small space available, it can be divided in proportion to the minimum guarantee bandwidths, for example, to be allocated to the child station side units to increase their established bandwidths. Likewise, in the normal operation, the bandwidth allocation controlling section 203 for the child station side units using the 1-system determines the bandwidth to be allocated to each child station side unit as follows from its child station side unit number and its minimum guarantee bandwidth and maximum bandwidth fed from the 0/1-system apportioning controlling section 201 for the child station side units. The bandwidth allocation controlling section 203 determines the bandwidth of each child station side unit such that the established bandwidth becomes greater than its minimum guarantee bandwidth and equal to or less than its maximum bandwidth, and the sum total of bandwidths of the child station side units does not exceed the maximum available bandwidth. Then, it notifies the 1-system PDS processing section 205 of the established bandwidths of the individual child station side units together with the 0/1-system selection information notifications indicating as to whether the 0-system or 1-system is selected by the child station side units.

In the 1-system PDS processing section 205, receiving the bandwidth change notification (when it detects that the cell bandwidth received from the child station side unit is greater or less than a predetermined threshold value, and supplies it to the bandwidth allocation controlling section 203 for the child station side units using the 1-system) of each child station side unit from the 1-system PDS processing section 205, the bandwidth allocation controlling section 203 for the child station side units using the 1-system increases the established bandwidth of the child station side unit, when the notification indicates a bandwidth greater than the threshold value, and the DBA usable bandwidth is available. On the other hand,

if the bandwidth is less than the threshold value, it can reduce the established bandwidth of the child station side unit. Here, the threshold value can take multiple values.

Receiving the bandwidth change notifications about a plurality of the child station side units, from which the cell bandwidths greater than the threshold value are received, it increases the established bandwidths of all the corresponding child station side units as long as the DBA usable bandwidth is available. In contrast, when the DBA usable bandwidth has only a small space available, it can be divided in proportion to the minimum guarantee bandwidths, for example, to be allocated to the child station side units to increase their established bandwidths.

Next, Fig. 2 will be described.

When the OAM cell extracted by the OAM cell demultiplexing section 212 includes a delay measurement cell, the delay amount measuring section 214 measures the round-trip delay from the response of the delay measurement cell.

The delay measurement cell generating section 216 computes the delay amount between the parent station side unit and the child station side unit from the round-trip delay, generates the delay measurement value information cell including information about the delay amount, and transmits it to the OAM cell generating section 220.

The OAM cell generating section 220 places the delay measurement value information cell into the OAM cell, and the transmitting/receiving section 211 transmits it to the child station side unit. When the cell is sent back from the child station side unit within the normal round-trip delay, the state controlling section 213 makes a decision that the child station side unit is in the operating state, and measures the delay amount of the upstream cell, so that the delay amount correcting section 215 carries out the fine adjustment of the delay amount. In contrast, when the cell is not sent back within the normal round-trip delay, it makes a decision that the child station side unit is in the abnormal condition. The operation thus far is the same as that of the conventional system.

The transmitting/receiving section 211 optically multiplexes the downstream signals to the child station side units and the upstream signals from the child station side units, and the OAM cell demultiplexing section 212 isolates the data cell and the OAM cells. The bandwidth monitor 217 for the child station side units monitors

the bandwidth of the cells sent from each child station side unit, and compares it with a threshold value set for each child station side unit. In the child station side unit (there is identified by its child station side unit number in the cell header, for example), when the bandwidth greater than or less than the threshold value is detected for a particular child station side unit (by counting the number of incoming cells in a fixed period, for example), it generates the bandwidth change notification for each child station side unit. The threshold value can set by dividing into multiple values.

The grant generating section 218 receives the established bandwidths and the 0/1-system selection information notifications of the child station side units from the bandwidth controlling section200 for the child station side units, and generates grants that define the output timings of respective child station side units on the one-by-one basis of the child station side units.

The 0/1-system selection information generating section 219 receives the 0/1-system selection information notifications from the bandwidth controlling section200 for the child station side units, and generates the 0/1-system selection information for each of the individual station side units.

The OAM cell generating section 220 multiplexes the grant information from the grant generating section 218 and the 0/1-system selection information notifications from the 0/1-system selection information generating section 219 into the OAM cell.

The OAM cell inserting section 221 multiplexes the OAM cells generated by the OAM cell generating section 220 into the downstream cells.

The 0/1-system selection information inserting section 222 multiplexes the 0/1-system selection information notifications from the 0/1-system selection information generating section 219 into the upstream cells.

The foregoing configuration that apportions the child station side units to the 0-system and 1-system makes it possible for the DBA to use the 1-system bandwidth, thereby enabling an effective use of the bandwidth, and increasing the maximum bandwidth of the DBA available by the child station side units.

Although the apportionment of the child station side units to the 0-system and 1-system is made such that the sum total of the minimum guarantee bandwidths of the m child station side units working on

the 0-system becomes nearly equal to that of the 1 child station side units working on the 1-system (m + 1 is the total number of the child station side units), this is not essential. For example, the apportionment of the child station side units to the 0-system and 1-system can be made such that the sum totals of the terms (maximum bandwidth - minimum guarantee bandwidth) of both the systems become nearly equal.

Alternatively, it is also possible to apportion the child station side units to the 0-system and 1-system such that the sum totals of the maximum bandwidths of the two systems become nearly equal.

Furthermore, it can also be made such that the sum totals of the established bandwidths (values set between the minimum guarantee bandwidth and the maximum bandwidth in the actual operation) of the two systems become nearly equal. This makes it possible for the parent station side unit to establish the bandwidths matching the actual traffic.

Although the dynamic bandwidth allocation control method is applied to the system comprising two systems, the 0-system and 1-system, in the present embodiment 1, this is not essential. For example, it is applicable to a system including three or more systems.

EMBODIMENT 2

Fig. 5 is a block diagram showing a configuration for implementing the dynamic bandwidth allocation control method in a duplex PDS configuration, and Fig. 6 is a block diagram showing a detailed configuration of the PDS processing section as shown in Fig. 5. In Figs. 5 and 6, the same or like portions to those of Figs. 1 and 2 are designated by the same reference numerals, and the description thereof is omitted here.

The reference numeral 206 designates a 0-system PDS processing section similar to the 0-system PDS processing section 204 except that it outputs a switching trigger Trg (0) together with child station side unit numbers, and supplies them to a switching controlling section 208. The reference numeral 207 designates a 1-system PDS processing section similar to the 1-system PDS processing section 205 except that it outputs a switching trigger Trg (1) together with the child station side unit numbers, and supplies them to the switching controlling section 208.

The reference numeral 208 designates the switching controlling section that receives the switching trigger Trg (0) and child station

side unit numbers from the 0-system PDS processing section 206, and the switching trigger Trg (1) and child station side unit numbers from the 1-system PDS processing section 207, that receives a forced switching request from a 0/1-system apportioning controlling section 209 for the child station side units, and generates switching information indicating one of the 0-system and the 1-system to which each child station side unit switches, and that supplies the information to the 0/1-system apportioning controlling section 209 for the child station side units, and actually controls the switching. The reference numeral 209 designates the 0/1-system apportioning controlling section for the child station side units that carries out the switching by generating the forced switching request for the switching controlling section 208 when it makes a decision from the switching information received from the switching controlling section 208 that the bandwidth apportionment between the 0-system and 1-system loses its balance because of the switching caused by a transmission line failure or the like, and hence at least one of the two systems cannot secure enough DBA usable bandwidth, and that restructures the bandwidth apportionment balance between the 0-system and 1-system so that the two systems can secure enough DBA usable bandwidth.

The reference numeral 223 designates a switching trigger detecting section for detecting a transmission line failure or logic card failure (EQP), and outputs the switching trigger Trg and child station side unit number about the corresponding child station side unit.

The switching trigger detecting section 223 of Fig. 6 detects, from the upstream data sent from each child station side unit, alarm information (such as a break of a signal input), and detects failure information on a logic card (device) and the like within the logic card (device). When the 0-system PDS processing section 206 detects a failure occurred in the child station side unit, it outputs the switching trigger Trg (0), whereas when the 1-system PDS processing section 207 detects a failure occurred in the child station side unit, it outputs the switching trigger Trg (1). These switching triggers Trg (0) and Trg (1) are supplied to the switching controlling section 208 along with the child station side unit number for identifying the child station side unit.

Receiving the switching trigger Trg (0) from the 0-system, the

switching controlling section 208 switches the child station side unit to the 1-system when the standby side (the 1-system here) is normal. Likewise, receiving the switching trigger Trg (1) from the 1-system, the switching controlling section 208 switches the child station side unit to the 0-system when the standby side (the 0-system here) is normal. In this case, the switching controlling section 208 generates the switching information indicating the child station side unit switched, and sends it to the 0/1-system apportioning controlling section 209 for the child station side units.

When the 0/1-system apportioning controlling section 209 for the child station side units makes a decision that the balance between the sum totals of the minimum guarantee bandwidths of the 0-system and 1-system is lost because of the switching, and hence at least one of the two systems cannot secure enough DBA usable bandwidth (for example, when the DBA usable bandwidth of one of the 0- and 1-systems becomes less than a predetermined threshold value because of the switching of the child station side units), the controller 209 decides one or more child station side units to be switched from the system having a smaller DBA usable bandwidth to the other system. It is preferable that the child station side units to be switched have a large established bandwidth, and are normal in the 0-system or 1-system. Then, the 0/1-system apportioning controlling section 209 sends to the switching controlling section 208 the forced switching request to switch the child station side units to the other system. Thus switching the normal child station side units that are selected in the 0-system or 1-system enables the difference between the sum totals of the minimum guarantee bandwidths of the 0-system and 1-system to be kept small, thereby securing enough DBA usable bandwidths in both the systems.

The switching controlling section 208, which decides the forced switching of the child station side unit to the other system when the other system is normal, supplies the 0/1-system apportioning controlling section 209 for the child station side units with the switching information (about carrying out the forced switching of the child station side unit to the other system).

Receiving the switching information (about carrying out the forced switching of the child station side unit to the other system), the 0/1-system apportioning controlling section 209 for the child station side units notifies the bandwidth allocation controlling

section 202 for the child station side units using the 0-system and the bandwidth allocation controlling section 203 for the child station side units using the 1-system, of the minimum guarantee bandwidth and maximum bandwidth of each child station side unit to be subjected to the reallocation to the 0-system and 1-system by the forced switching. Receiving the information, the bandwidth allocation controllers 202 and 203 notify the 0-system PDS processing section 206 and 1-system PDS processing section 207 of the established bandwidths of the respective child station side units to be subjected to the reallocation caused by the apportioning change. Receiving the information, the 0-system PDS processing section s 206 and 207 transmit the system selection information upstream by inserting it into the cell header, and the system selection information and bandwidth established information downstream by an OAM cell.

The switching controlling section 208 carries out the forced switching of the child station side unit to the other system. The remaining operation is the same as that of the foregoing embodiment 1.

The foregoing configuration enables the forced switching of the normal child station side units when at least one of the two systems cannot secure enough DBA usable bandwidth because of the imbalance between the sum totals of the minimum guarantee bandwidths of the 0-system and 1-system due to a failure or the like. Thus, it can regain the balance between the sum totals of the minimum guarantee bandwidths of the 0-system and 1-system (making it possible for the two systems to secure enough DBA usable bandwidth) and to increase the DBA available bandwidth.

EMBODIMENT 3

Although the foregoing embodiment 1 carries out the switching and bandwidth allocation on a child station side unit basis, the present embodiment 3 carries them out on a VP (Virtual Path) basis. Since the child station side unit can establish a plurality of VPs, the selection between the 0-system transmission line and the 1-system transmission line can take place for each VP even within the same child station side unit.

Using Fig. 4, a configuration of a duplex optical distribution system for the VP-based switching will be described. Both the parent station side unit and child station side units carry out the VP-based switching. It will take place that one VP in a particular child

station side unit employs the 0-system transmission line as the working side, but another VP thereof uses the 1-system transmission line as the working side. In Fig. 4, the child station side unit 101 is connected to the parent station side unit 100 via the optical couplers 102.

In the child station side unit, the 0-system signal termination 116a and the 1-system signal termination 116b are connected to the optical couplers 102 through the optical fibers, and process the downstream signals from the parent station side unit 100 to divide the services to n signals for individual LIMs, where n is the number of the LIMs. In addition, they extracts the system selection information on the 0/1-system transmission line for respective VPs from the OAM cells of the downstream signals. Besides, they send to the parent station side unit 100 upstream signals each of which includes n signals that correspond to the LIMs and are multiplexed to the upstream signal.

The system selection signal generating section 117 receives the system selection information on the 0/1-system transmission lines for respective VPs from the 0-system signal termination 116a and 1-system signal termination 116b, and supplies it to the 2-1 SEL 118 for selecting downstream signals, and to the upstream route setting section 119.

The 2-1 SEL 118 selects one of two sets of n signals supplied from the 0-system signal termination 116a and 1-system signal termination 116b in response to the selection information for respective VPs from the system selection signal generating section 117, and transmits the selected signals to the corresponding LIMs.

The route setting section 119 routes a set of n upstream signals LIM1 - LIMn to either the 0-system signal termination 116a or 1-system signal termination 116b in response to the system selection information on the individual VPs fed from the system selection signal generating section 117.

In the parent station side unit 100, the PDS-IF(0) 114a and the PDS-IF(1) 114b are connected to the optical couplers 102 through optical fibers.

The system selection signal generating section 115 generates system selection information on each VP from information about a fault of the transmission line. For example, if a transmission line failure of a VP operating on the 0-system is detected, and when the 1-system

VP transmission line is normal, the system selection signal generating section 115 generates the switching information to the 1-system VP, or vice versa. Then, the system selection signal generating section 115 supplies the switching information to the SEL 112 for selecting the upstream signal and to the downstream route setting section 113.

The SEL 112 selects one of the signals supplied from the PDS-IF(0) 114a and PDS-IF(1) 114b on one-by-one basis of the VPs in response to the system selection information on the 0/1-system transmission lines for individual VPs fed from the system selection signal generating section 115.

The route setting section 113 routes the input signal to one of the PDS-IF(0) 114a and PDS-IF(1) 114b on a one-by-one basis of the VPs in response to the system selection information for individual VPs fed from the system selection signal generating section 115.

Next, a concrete operation will be described taking an example where two child station side units #1 and #2 are connected to the parent station side unit 100.

Assume that the VP=0 of the child station side unit #1 uses the 0-system as the working side, and the VP=1 of the child station side unit #1 employs the 1-system as the working side. In this case, in the VP=1 of the child station side unit #1, the system selection signal generating section 117 extracts the system selection information for selecting the 0-system from the downstream signal, and supplies it to the 2-1 SEL 118 and route setting section 119, so that the upstream signals are sent to the 0-system, and the downstream signals are also selected from the 0-system.

In the VP=1 of the child station side unit #1, the system selection signal generating section 117 extracts the system selection information for selecting the 1-system from the downstream signal, and supplies it to the 2-1 SEL 118 and route setting section 119, so that the upstream signals are sent to the 1-system, and the downstream signals are also selected from the 1-system.

As for the downstream processing of the parent station side unit 100, the route setting section 113 selects one of the 0-system and 1-system signals by routing in response to the system selection information on individual VPs fed from the system selection signal generating section 115. As for the upstream processing, the SEL 112 carries out the signal selection in response to the system selection information on individual VPs fed from the system selection signal

generating section 115, thereby carrying out the signal switching (multiplexing) between the 0-system and 1-system for each of the VPs independently. Thus, the switching on a one-by-one basis of the VPs is carried out.

Fig. 7 is a block diagram showing a configuration for implementing the dynamic bandwidth allocation control method in the duplex PDS configuration. In the figure, the reference numeral 300 designates a bandwidth controlling section (bandwidth control means) for individual VPs; 301 designates a 0/1-system apportioning controlling section for the individual VPs; 302 designates a bandwidth allocation controlling section for the VPs using the 0-system; 303 designates a bandwidth allocation controlling section for the VPs using the 1-system; 304 designates a 0-system PDS processing section; and 305 designates a 1-system PDS processing section.

Fig. 8 is a block diagram showing a detailed configuration of the PDS processing section as shown in Fig. 7. In this figure, the reference numeral 311 designates a transmitting/receiving section, 312 designates an OAM cell demultiplexing section, 313 designates a state controlling section, 314 designates a delay amount measuring section, 315 designates a delay amount correcting section, 316 designates a delay measurement cell generating section, 317 designates a VP bandwidth monitor for detecting the bandwidth of each VP, 318 designates a grant generating section, 319 designates a 0/1-system selection information generating section, 320 designates an OAM cell generating section, 321 designates an OAM cell inserting section, and 322 designates a 0/1-system selection information inserting section.

The 0/1-system apportioning controlling section 301 for individual VPs divides all the VPs to the VPs working on the 0-system and the VPs working on the 1-system when starting the duplex distribution network system or adding new VPs. Specifically, the bandwidth allocation is made as follows: First, a minimum transmission bandwidth is assigned to each VP independently in either the 0-system or 1-system when the two systems are normal; and second, the remaining bandwidth is reserved as a dynamic allocation bandwidth so that when one of the two systems fails in any of the VPs, their transmission bandwidths are secured dynamically in the dynamic allocation bandwidth of the normal system.

For example, the division of the VPs to the 0/1-system is made

such that the sum total of the minimum guarantee bandwidths WLi of the m VPs working on the 0-system becomes nearly equal to the sum total of the minimum guarantee bandwidths WLi of the l VPs working on the 1-system, where m is an arbitrary number between zero and n that is the total number of the VPs established, and m + l = n. Thus, as for the DBA bandwidth, both the 0-system and 1-system can secure the bandwidth equal to the maximum available bandwidth - (the sum total of the minimum guarantee bandwidths WLi), thereby making it possible for the DBA to utilize the 1-system bandwidth, and to make effective use of the bandwidth. Furthermore, the 0/1-system apportioning controlling section 301 determines the maximum bandwidths of the individual VPs, and supplies VPI numbers for identifying the VPs along with the set values of the minimum guarantee bandwidths and maximum bandwidths to the bandwidth allocation controlling section 302 for the VPs using the 0-system and to the bandwidth allocation controlling section 303 of the VPs using the 1-system.

The bandwidth allocation controlling section 302 for the VPs using the 0-system receives the VP numbers together with the set values of the minimum guarantee bandwidths and maximum bandwidths from the 0/1-system apportioning controlling section 301 for the individual VPs, and carries out the DBA processing in response to the information. More specifically, in the normal operation, the bandwidth allocation controlling section 302 determines the bandwidth to be allocated to each VP from the VP number and the set values of the minimum guarantee bandwidth and maximum bandwidth fed from the 0/1-system apportioning controlling section 301 for the individual VPs such that the established bandwidth of each VP becomes greater than the minimum guarantee bandwidth and equal to or less than the maximum bandwidth, and the sum total of the bandwidths of the VPs does not exceed the maximum available bandwidth. Then, it transfers to the 0-system PDS processing section 304 the established bandwidths of the individual VPs, along with the 0/1-system selection information notifications indicating one of the 0-system and 1-system to be selected by the individual VPs.

The 0-system PDS processing section 304 generates a bandwidth change notification for each VP when it detects that the cell bandwidth received from the VP is greater or less than a predetermined threshold value, and supplies it to the bandwidth allocation controlling section

302 for the VPs using the 0-system. Receiving the bandwidth change notification of each VP from the 0-system PDS processing section 304, the bandwidth allocation controlling section 302 for the VPs using the 0-system increases the established bandwidth of the VP, when the notification indicates that the bandwidth is greater than the threshold value, and the DBA usable bandwidth is available. On the other hand, if the bandwidth is less than the threshold value, it can reduce the established bandwidth of the VP. Here, the threshold value can take multiple values.

Receiving the bandwidth change notifications about the plurality of the VPs, from which the cell bandwidths greater than the threshold value are received, it increases the established bandwidths of all the corresponding VPs as long as the DBA usable bandwidth is available. In contrast, when the DBA usable bandwidth has only a small space available, it can be divided in proportion to the minimum guarantee bandwidths, for example, to be allocated to the VPs to increase their established bandwidths.

Likewise, in the 1-system, the bandwidth allocation controlling section 303 of the VPs using the 1-system receives the VP numbers together with the set values of the minimum guarantee bandwidths and maximum bandwidths from the 0/1-system apportioning controlling section 301 for the individual VPs, and carries out the DBA processing in response to the information. More specifically, in the normal operation, the bandwidth allocation controlling section 303 determines the bandwidth to be allocated to each VP from its VP number and the set values of its minimum guarantee bandwidth and maximum bandwidth supplied from the 0/1-system apportioning controlling section 301 for the individual VPs such that the established bandwidth of each VP becomes greater than the minimum guarantee bandwidth and equal to or less than the maximum bandwidth, and the sum total of bandwidths of the VPs does not exceed the maximum available bandwidth. Then, it transfers to the 1-system PDS processing section 305 the established bandwidths of the individual VPs, along with the 0/1-system selection information notifications indicating one of the 0-system and 1-system to be selected by the individual VPs.

The 1-system PDS processing section 305 generates a bandwidth change notification for each VP when it detects that the cell bandwidth received from the VP is greater or less than a predetermined threshold value, and supplies it to the bandwidth allocation controlling section

303 for the VPs using the 1-system. Receiving the bandwidth change notification of each VP from the 1-system PDS processing section 305, the bandwidth allocation controlling section 303 for the VPs using the 1-system increases the established bandwidth of the VP, when the notification indicates that the bandwidth is greater than the threshold value, and the DBA usable bandwidth is available. On the other hand, if the bandwidth is less than the threshold value, it can reduce the established bandwidth of the VP. Here, the threshold value can take multiple values.

Receiving the bandwidth change notifications about the plurality of the VPs, from which the cell bandwidths greater than the threshold value are received, it increases the established bandwidths of all the corresponding VPs as long as the DBA usable bandwidth is available. In contrast, when the DBA usable bandwidth has only a small space available, it can be divided in proportion to the minimum guarantee bandwidths, for example, to be allocated to the VPs to increase their established bandwidths.

Next, Fig. 8 will be described.

When the OAM cell extracted by the OAM cell demultiplexing section 312 includes a delay measurement cell, the delay amount measuring section 314 measures the round-trip delay from the response of the delay measurement cell.

The delay measurement cell generating section 316 computes the delay amount between the parent station side unit and the child station side unit from the round-trip delay, generates the delay measurement value information cell including information about the delay amount, and transmits it to the OAM cell generating section 320.

The OAM cell generating section 320 places the delay measurement value information cell into the OAM cell, and the transmitting/receiving section 311 transmits it to the child station side unit. When the cell is sent back from the child station side unit within the normal round-trip delay, the state controlling section 313 makes a decision that the child station side unit is in the operating state, and measures the delay amount of the upstream cell, so that the delay amount correcting section 315 carries out the fine adjustment of the delay amount. In contrast, when the cell is not sent back within the normal round-trip delay, it makes a decision that the child station side unit is in the abnormal condition. The operation thus far is the same as that of the conventional system.

The transmitting/receiving section 311 optically multiplexes the downstream signals to the child station side units and the upstream signals from the child station side units, and the OAM cell demultiplexing section 312 isolates the data cell and the OAM cells.

The bandwidth monitor 317 for the individual VPs detects the bandwidth of the cells sent from each child station side unit, and compares it with a threshold value set for each VP. Detecting the bandwidth greater than or less than the threshold value for the VP (the VP is identified by the VPI number, for example) by counting the number of incoming cells in a fixed period, for example, the bandwidth monitor 317 generates the bandwidth change notification for each VP. The threshold value can take multiple values.

The grant generating section 318 receives the established bandwidth and the 0/1-system selection information notification of each VP from the bandwidth controlling section300 for the individual VPs, and generates grants that define the output timings of the respective VPs on the one-by-one basis of the VPs.

The 0/1-system selection information generating section 319 receives the 0/1-system selection information notification from the bandwidth controlling section300 for the individual VPs, and generates the 0/1-system selection information for each of the VPs.

The OAM cell generating section 320 multiplexes the grant information from the grant generating section 318 and the 0/1-system selection information from the 0/1-system selection information generating section 319 into the OAM cell.

The OAM cell inserting section 321 multiplexes the OAM cells generated by the OAM cell generating section 320 into the downstream cells.

The 0/1-system selection information inserting section 322 multiplexes the 0/1-system selection information fed from the 0/1-system selection information generating section 319 into the upstream cells on a one-by-one basis of the VPs.

The foregoing configuration that apportions the VPs to the 0-system and 1-system makes it possible for the DBA to use the 1-system bandwidth, thereby enabling an effective use of the bandwidth, and increasing the maximum bandwidth of the DBA available by the all the VPs in common.

Although the apportionment of the VPs to the 0-system and 1-system is made such that the sum total of the minimum guarantee

bandwidths of the m VPs working on the 0-system becomes nearly equal to that of the l VPs working on the 1-system (m + l is the total number of the child station side units) this is not essential. For example, the apportionment of the VPs to the 0-system and 1-system can be made such that the sum totals of the terms (maximum bandwidth - minimum guarantee bandwidth) of both the systems become nearly equal.

Alternatively, it is also possible to apportion the VPs to the 0-system and 1-system such that the sum totals of the maximum bandwidths of the two systems become nearly equal.

Furthermore, it can also be made such that the sum totals of the established bandwidths of the VPs of the two systems become nearly equal. This makes it possible to establish the bandwidths matching the actual traffic.

Although the dynamic bandwidth allocation control method is applied to the system comprising the two systems (the 0-system and 1-system) in the present embodiment 3, this is not essential. For example, it is applicable to a system including three or more systems.

EMBODIMENT 4

Fig. 9 is a block diagram showing a configuration for implementing the dynamic bandwidth allocation control method in a duplex PDS configuration, and Fig. 10 is a block diagram showing a detailed configuration of a PDS processing section as shown in Fig. 9. In Figs. 9 and 10, the same or like portions to those of Figs. 7 and 8 are designated by the same reference numerals, and the description thereof is omitted here.

The reference numeral 306 designates a 0-system PDS processing section similar to the 0-system PDS processing section 304 except that it outputs a switching trigger Trg (0) and VP numbers, and supplies them to a switching controlling section 308. The reference numeral 307 designates a 1-system PDS processing section similar to the 1-system PDS processing section 305 except that it outputs a switching trigger Trg (1) and VP numbers, and supplies them to the switching controlling section 308.

The reference numeral 308 designates the switching controlling section that receives the switching trigger Trg (0) and VP numbers from the 0-system PDS processing section 306, and the switching trigger Trg (1) and VP numbers from the 1-system PDS processing section 307, that receives a forced switching request from a 0/1-system apportioning controlling section 309 for the individual VPs, and

generates switching information indicating one of the 0-system and the 1-system to which each VP is switched, and that supplies the information to the 0/1-system apportioning controlling section 309 for the individual VPs, and actually controls the switching. The reference numeral 309 designates the 0/1-system apportioning controlling section for the individual VPs that carries out the switching by generating the forced switching request for the switching controlling section 308 when it makes a decision from the switching information received from the switching controlling section 308 that the bandwidth apportionment between the 0-system and 1-system loses its balance because of the switching caused by a transmission line failure or the like, and hence at least one of the two systems cannot secure enough DBA usable bandwidth, and that regains the bandwidth apportionment balance between the 0-system and 1-system (the two systems can secure enough DBA usable bandwidth). The reference numeral 323 designates a switching trigger detecting section for detecting a transmission line failure or logic card failure (EQP), and outputs the switching trigger Trg and VP number about the corresponding VP.

The switching trigger detecting section 323 of Fig. 10 detects alarm information on each VP (such as a break of a signal input) from the upstream data sent from the VP, and detects failure information on a logic card (device) and the like within the logic card (device). When it detects the failure in the 0-system PDS processing section 306 for each VP, it outputs the switching trigger Trg (0) for the fault VP, whereas when it detects the failure in the 1-system PDS processing section 307, it outputs the switching trigger Trg (1) for the fault VP. These switching triggers Trg (0) and Trg (1) are supplied to the switching controlling section 308 along with the VP numbers (number for identifying the VPs).

Receiving the switching trigger Trg (0) from the 0-system, the switching controlling section 308 switches the VP to the 1-system when the standby side (the 1-system here) is normal. Likewise, receiving the switching trigger Trg (1) from the 1-system, the switching controlling section 308 switches the VP to the 0-system when the standby side (the 0-system here) is normal. In this case, the switching controlling section 308 generates the switching information indicating the VP that is switched, and supplies it to the 0/1-system apportioning controlling section 309 for the

individual VPs.

When the 0/1-system apportioning controlling section 309 for the individual VPs makes a decision that the balance between the sum totals of the minimum guarantee bandwidths of the 0-system and 1-system is lost because of the switching, and hence at least one of the two systems cannot secure enough DBA usable bandwidth (for example, when the DBA usable bandwidth of one of the 0-system and 1-systems becomes less than a predetermined threshold value because of the switching of the VPs), the controller 309 decides one or more VPs to be switched from the system having a smaller DBA usable bandwidth to the other system. It is preferable that the VPs to be switched have a large established bandwidth, and are normal in the 0-system or 1-system. Then, the 0/1-system apportioning controlling section 309 supplies the switching controlling section 308 with the forced switching request to switch the VPs to the other system. Thus switching the normal VPs that are selected in the 0-system or 1-system enables the difference between the sum totals of the minimum guarantee bandwidths of the 0-system and 1-system to be kept small, thereby securing enough DBA usable bandwidths in both the systems.

The switching controlling section 308 decides the forced switching of the child station side unit to the other system, when the other system is normal, and supplies the 0/1-system apportioning controlling section 309 for the individual VPs with the switching information (about carrying out the forced switching of the VP to the other system).

Receiving the switching information (about carrying out the forced switching of the VP to the other system), the 0/1-system apportioning controlling section 309 for the individual VPs notifies the bandwidth allocation controlling section 302 for the VPs using the 0-system and the bandwidth allocation controlling section 303 for the VPs using the 1-system, of the minimum guarantee bandwidth and maximum bandwidth of each VP after the reallocation to the 0-system and 1-systems by the forced switching. Receiving the information, the bandwidth allocation controllers 302 and 303 notify the 0-system PDS processing section 306 and 1-system PDS processing section 307 of the established bandwidth of each VP subjected to the reallocation caused by the apportioning change. Receiving the information, the 0-system PDS processing section s 306 and 307 transmit the system selection information upstream by inserting it into the cell header,

and the system selection information and bandwidth established information downstream by an OAM cell. The switching controlling section 308 carries out the forced switching of the VPs to the other system. The remaining operation is the same as that of the foregoing embodiment 3.

The foregoing configuration enables the forced switching of the normal VPs even when at least one of the two systems cannot secure enough DBA usable bandwidth because of the imbalance between the sum totals of the minimum guarantee bandwidths of the 0-system and 1-system due to a failure or the like, thereby regaining the balance between the sum total of the minimum guarantee bandwidths of the 0-system and that of the 1-system (the two systems to secure enough DBA usable bandwidth), and to increase the DBA available bandwidth.

[Effects of the Invention]

As mentioned above, according to the present invention, since the plurality of child station side units are apportioned to the first optical network and the second optical network, for allocating a predetermined transmission bandwidth to each of the plurality of child station side units, and for accepting a bandwidth change of the transmission bandwidth, there is an effect that the child station side unit secures a large DBA usable bandwidth on the DBA operation.

According to the present invention, since the bandwidth control means allocates all transmission bandwidths of the child station side units to the other optical network when a failure occurs in one of the first optical network and the second optical network, there is an effect that even if the failure occurs in one of the optical networks, the data transmission can be continued.

According to the present invention, since the bandwidth control means switches the working side child station side unit to a standby side, and switches a standby side child station side unit to the working side when a failure occurs in a working side child station side unit of the plurality of child station side units, there is an effect that even if the failure occurs in one of the working child station side unit, the data transmission can be continued.

According to the present invention, since the bandwidth control means carries out apportionment of the plurality of child station side units between the first optical network and the second optical network again when apportionment balance is lost of the plurality of child station side units between the first optical network and

the second optical network, there is an effect of enabling an effective use of the bandwidth, and increasing the maximum bandwidth of the DBA available by the child station side units.

According to the present invention, since the bandwidth control means allocates a minimum guarantee bandwidth to the plurality of child station side units, there is an effect that the minimum bandwidth can be secured.

According to the present invention, since the bandwidth control means apportions the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of minimum guarantee bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of minimum guarantee bandwidths of each of the child station side units in the second optical network, there is an effect of enabling an effective use of the bandwidth.

According to the present invention, since the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of maximum bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of maximum bandwidths of each of the child station side units in the second optical network, there is an effect of enabling an effective use of the bandwidth.

According to the present invention, since the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of each of the child station side units in the second optical network, there is an effect of enabling an effective use of the bandwidth.

According to the present invention, since the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of established bandwidths of each of the child station side units in the first optical network becomes nearly equal to a sum total of established bandwidths of each of the child station

side units in the second optical network, there is an effect of enabling an effective use of the bandwidth.

According to the present invention, since a plurality of paths contained in the plurality of child station side units are apportioned to the first optical network and the second optical network, for allocating a predetermined transmission bandwidth to each of the path, and for accepting a bandwidth change of the transmission bandwidth, there is an effect that the child station side unit secures a large DBA usable bandwidth on the DBA operation.

According to the present invention, since the bandwidth control means allocates all the paths contained in the plurality of child station side units to the other optical network when a failure occurs in one of the first optical network and the second optical network, there is an effect that the child station side unit secures a large DBA usable bandwidth on the DBA operation.

According to the present invention, since the bandwidth control means switches the path to a standby side, and switches a standby side path to the working side when a failure occurs in a working side path of the plurality of paths, there is an effect that even if the failure occurs in a working side path, the data transmission can be continued.

According to the present invention, since the bandwidth control means carries out apportionment of the plurality of paths between the first optical network and the second optical network again when apportionment balance is lost of the plurality of paths between the first optical network and the second optical network, there is an effect of enabling an effective use of the bandwidth, and increasing the maximum bandwidth of the DBA available by the child station side units.

According to the present invention, since the bandwidth control means allocates a minimum guarantee bandwidth to the plurality of paths, there is an effect that the minimum bandwidth can be secured.

According to the present invention, since the bandwidth control means apportions the plurality of paths to one of the first optical network and the second optical network such that a sum total of minimum guarantee bandwidths of the paths in the first optical network becomes nearly equal to a sum total of minimum guarantee bandwidths of the paths in the second optical network, there is an effect of enabling an effective use of the bandwidth.

According to the present invention, since the bandwidth control means apportions the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of maximum bandwidths of the paths in the first optical network becomes nearly equal to a sum total of maximum bandwidths of the paths in the second optical network, there is an effect of enabling an effective use of the bandwidth.

According to the present invention, since the bandwidth control means apportions the plurality of paths to one of the first optical network and the second optical network such that a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of the paths in the first optical network becomes nearly equal to a sum total of differences between maximum bandwidths and minimum guarantee bandwidths of the paths in the second optical network, there is an effect of enabling an effective use of the bandwidth.

According to the present invention, since the bandwidth control means apportions each of the plurality of child station side units to one of the first optical network and the second optical network such that a sum total of established bandwidths of the paths in the first optical network becomes nearly equal to a sum total of established bandwidths of the paths in the second optical network, there is an effect of enabling an effective use of the bandwidth.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a block diagram showing a configuration for implementing a dynamic bandwidth allocation control method in a duplex PDS configuration.

Fig. 2 is a block diagram showing a detailed configuration of the PDS processing section as shown in Fig. 1.

Fig. 3 is a schematic diagram illustrating an outline of the dynamic bandwidth allocation control method in the duplex PDS configuration.

Fig. 4 is a block diagram showing a configuration of a duplex optical distribution system that carries out branch switching.

Fig. 5 is a block diagram showing a configuration for implementing a dynamic bandwidth allocation control method in a duplex PDS configuration.

Fig. 6 is a block diagram showing a detailed configuration of the PDS processing section as shown in Fig. 5.

Fig. 7 is a block diagram showing a configuration for implementing a dynamic bandwidth allocation control method in a duplex PDS configuration.

Fig. 8 is a block diagram showing a detailed configuration of the PDS processing section as shown in Fig. 7.

Fig. 9 is a block diagram showing a configuration for implementing a dynamic bandwidth allocation control method in a duplex PDS configuration.

Fig. 10 is a block diagram showing a detailed configuration of the PDS processing section as shown in Fig. 9.

Fig. 11 is a block diagram showing a conventional optical multi-distribution communication system.

Fig. 12 is a block diagram showing a detailed configuration of the optical multi-distribution communication system of Fig. 11.

Fig. 13 is a block diagram showing a conventional duplex optical multi-distribution communication system that completely duplexes parent station side units and child station side units.

Fig. 14 is a schematic diagram illustrating an outline of the DBA.

[Detailed Description of the Reference Numerals]

100 … parent station side unit; 101 … child station side unit; 102 … optical coupler; 111 … 0/1-system selecting section; 112 … SEL; 113 … route setting section; 114a … PDS-IF(0); 114b … PDS-IF(1); 115 … system selection signal generating section; 116a … 0-system signal termination; 116b … 1-system signal termination; 117 … system selection signal generating section; 118 … 2-1 SEL; 119 … route setting section; 120-1 - 120-n … LIM; 200 … bandwidth controlling section for child station side unit (bandwidth control means); 201 … 0/1-system apportioning controlling section for child station side unit; 202 … bandwidth allocation controlling section for child station side unit using 0-system; 203 … bandwidth allocation controlling section for child station side unit using 1-system; 204 … 0-system PDS processing section; 205 … 1-system PDS processing section; 206 … 0-system PDS processing section; 207 … 1-system PDS processing section; 208 … switching controlling section; 209 … 0/1-system apportioning controlling section for child station side unit; 211 … transmitting/receiving section; 212 … OAM cell demultiplexing section; 213 … state controlling section; 214 … delay amount measuring section; 215 … delay amount correcting section; 216 … delay

measurement cell generating section; 217 ... bandwidth monitor for child station side unit; 218 ... grant generating section; 219 ... 0/1-system selection information generating section; 220 ... OAM cell generating section; 221 ... OAM cell inserting section; 222 ... 0/1-system selection information inserting section; 223 ... switching trigger detecting section; 300 ... bandwidth controlling section for individual VP (bandwidth control means); 301 ... 0/1-system apportioning controlling section for individual VP; 302 ... bandwidth allocation controlling section for VP using 0-system; 303 ... bandwidth allocation controlling section for VP using 1-system; 304 ... 0-system PDS processing section; 305 ... 1-system PDS processing section; 306 ... 0-system PDS processing section; 307 ... 1-system PDS processing section; 308 ... switching controlling section; 309 ... 0/1-system apportioning controlling section; 311 ... transmitting/receiving section; 312 ... OAM cell demultiplexing section; 313 ... state controlling section; 314 ... delay amount measuring section; 315 ... delay amount correcting section; 316 ... delay measurement cell generating section; 317 ... VP bandwidth monitor of each VP; 318 ... grant generating section; 319 ... 0/1-system selection information generating section; 320 ... OAM cell generating section; 321 ... OAM cell inserting section; 322 ... 0/1-system selection information inserting section; and 323 ... switching trigger detecting section.

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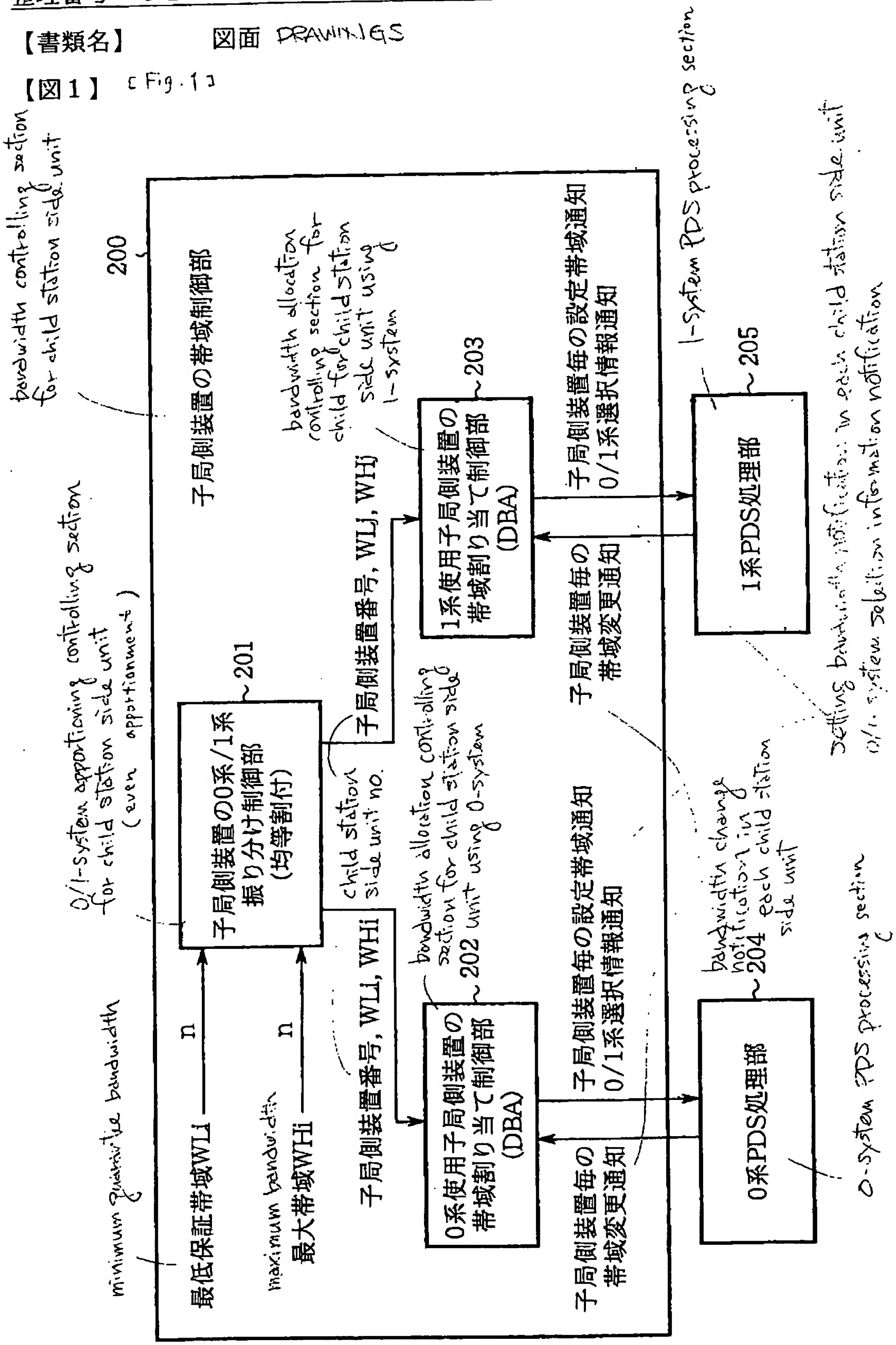
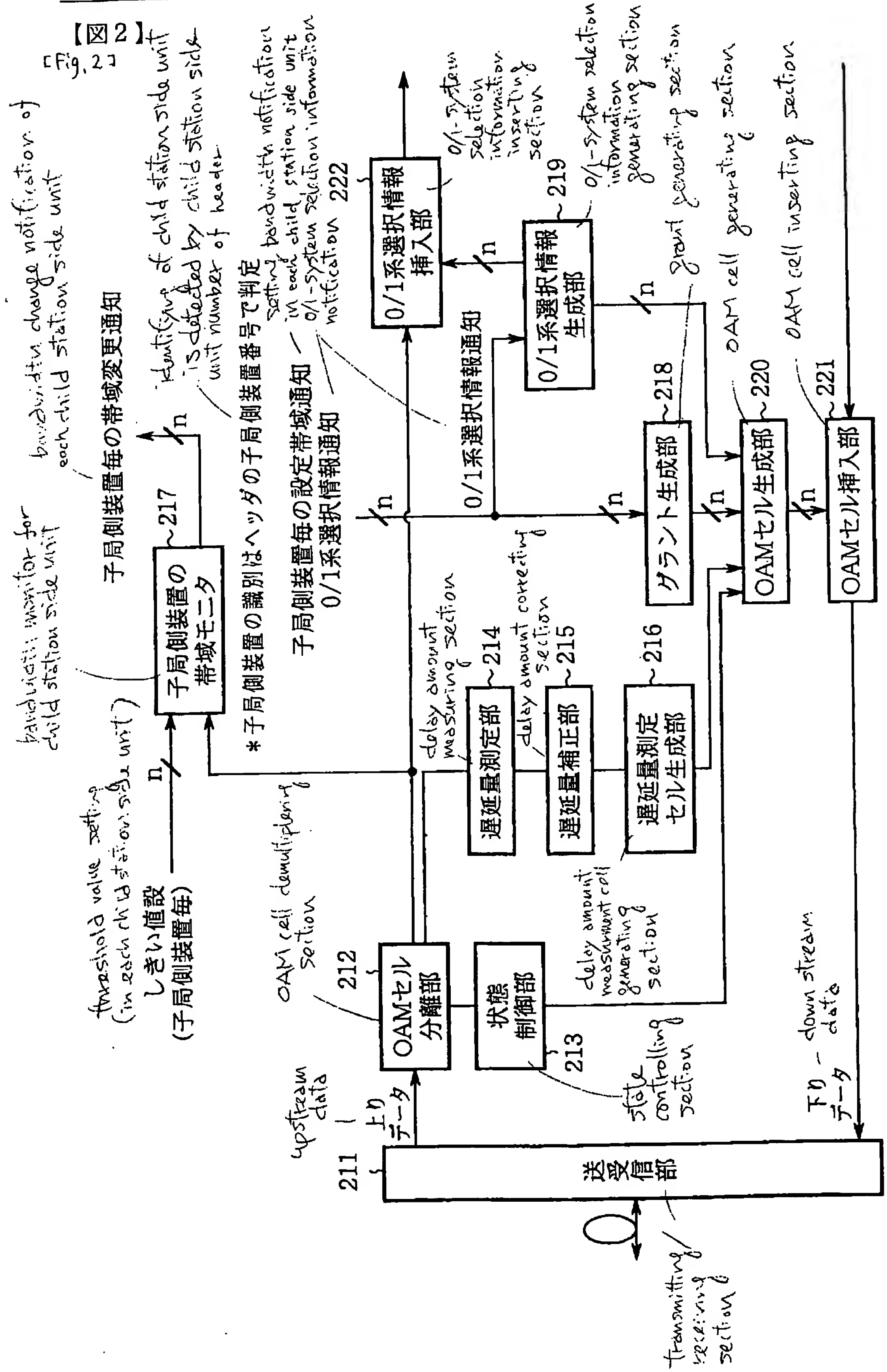
整理番号＝５２６８３５ＪＰ０１ 頁： 1/ 13

【書類名】 図面 DRAWINGS

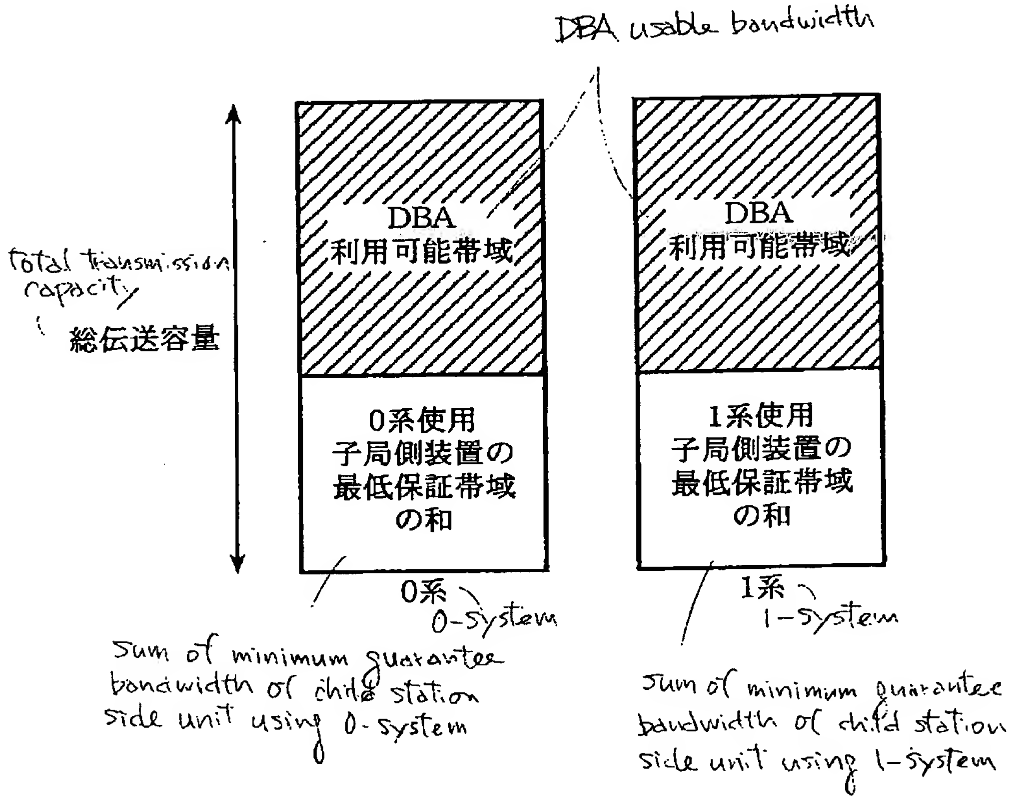
【図１】 [Fig.1]



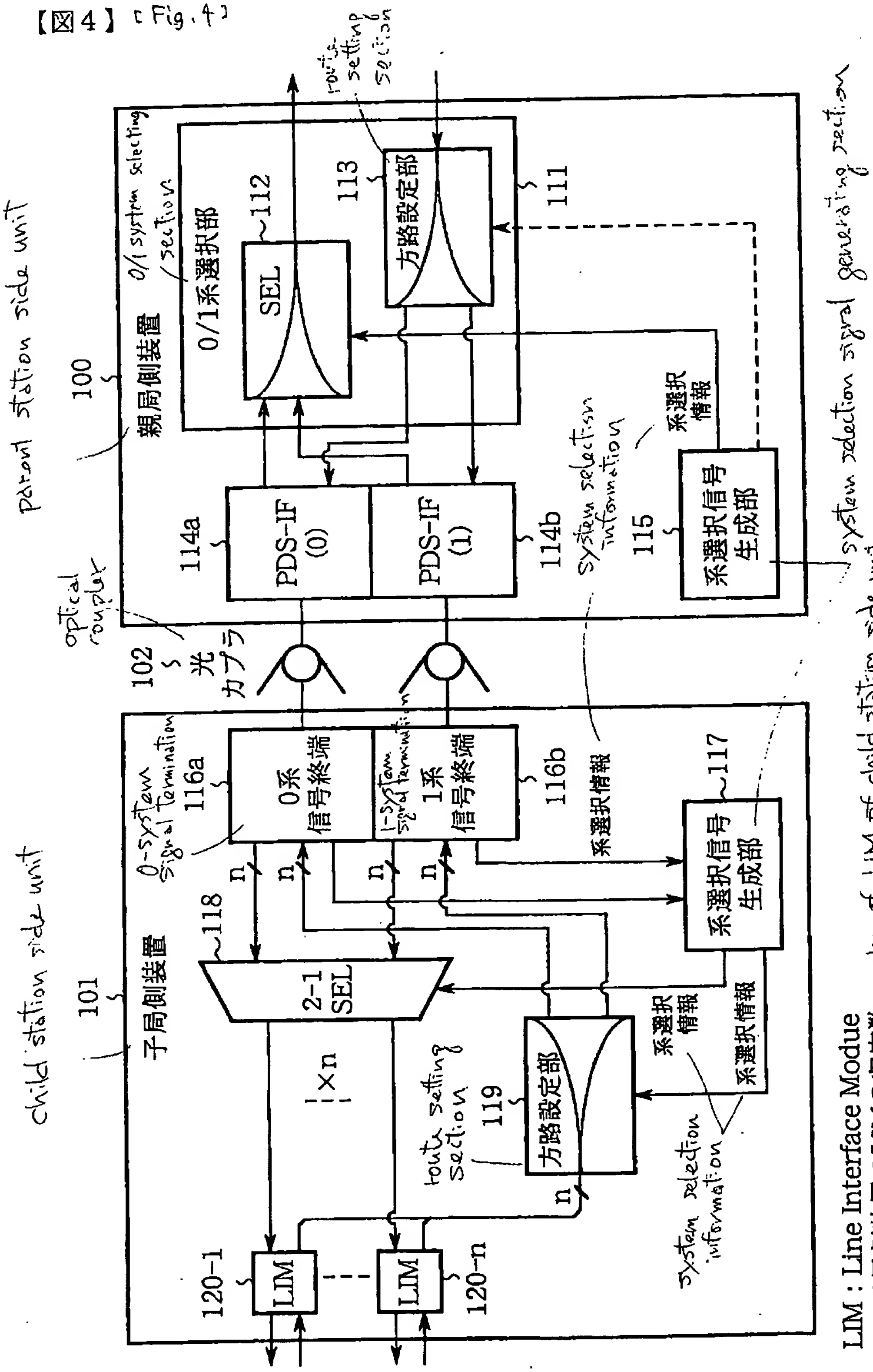
【図２】
[Fig.2]


しきい値設
(子局側装置毎)
threshold value setting (in each child station side unit)
子局側装置の帯域モニタ
217
bandwidth monitor for child station side unit
子局側装置毎の帯域変更通知
bandwidth change notification of each child station side unit
＊子局側装置の識別はヘッダの子局側装置番号で判定
identifying of child station side unit is detected by child station side unit number of header
子局側装置毎の設定帯域通知
setting bandwidth notification in each child station side unit
0/1系選択情報通知
0/1-system selection information notification
送受信部
211
transmitting/receiving section
上りデータ
upstream data
下りデータ
downstream data
OAMセル分離部
212
OAM cell demultiplexing section
状態制御部
213
state controlling section
遅延量測定部
214
delay amount measuring section
遅延量補正部
215
delay amount correcting section
遅延量測定セル生成部
216
delay amount measurement cell generating section
グラント生成部
218
grant generating section
0/1系選択情報生成部
219
0/1-system selection information generating section
OAMセル生成部
220
OAM cell generating section
OAMセル挿入部
221
OAM cell inserting section
0/1系選択情報挿入部
222
0/1-system selection information inserting section
n

【図３】 [Fig. 3]


DBA usable bandwidth
DBA
利用可能帯域
DBA
利用可能帯域
total transmission capacity
総伝送容量
0系使用
子局側装置の
最低保証帯域
の和
1系使用
子局側装置の
最低保証帯域
の和
0系
0-system
1系
1-system
Sum of minimum guarantee bandwidth of child station side unit using 0-system
Sum of minimum guarantee bandwidth of child station side unit using 1-system

【図４】[Fig. 4]

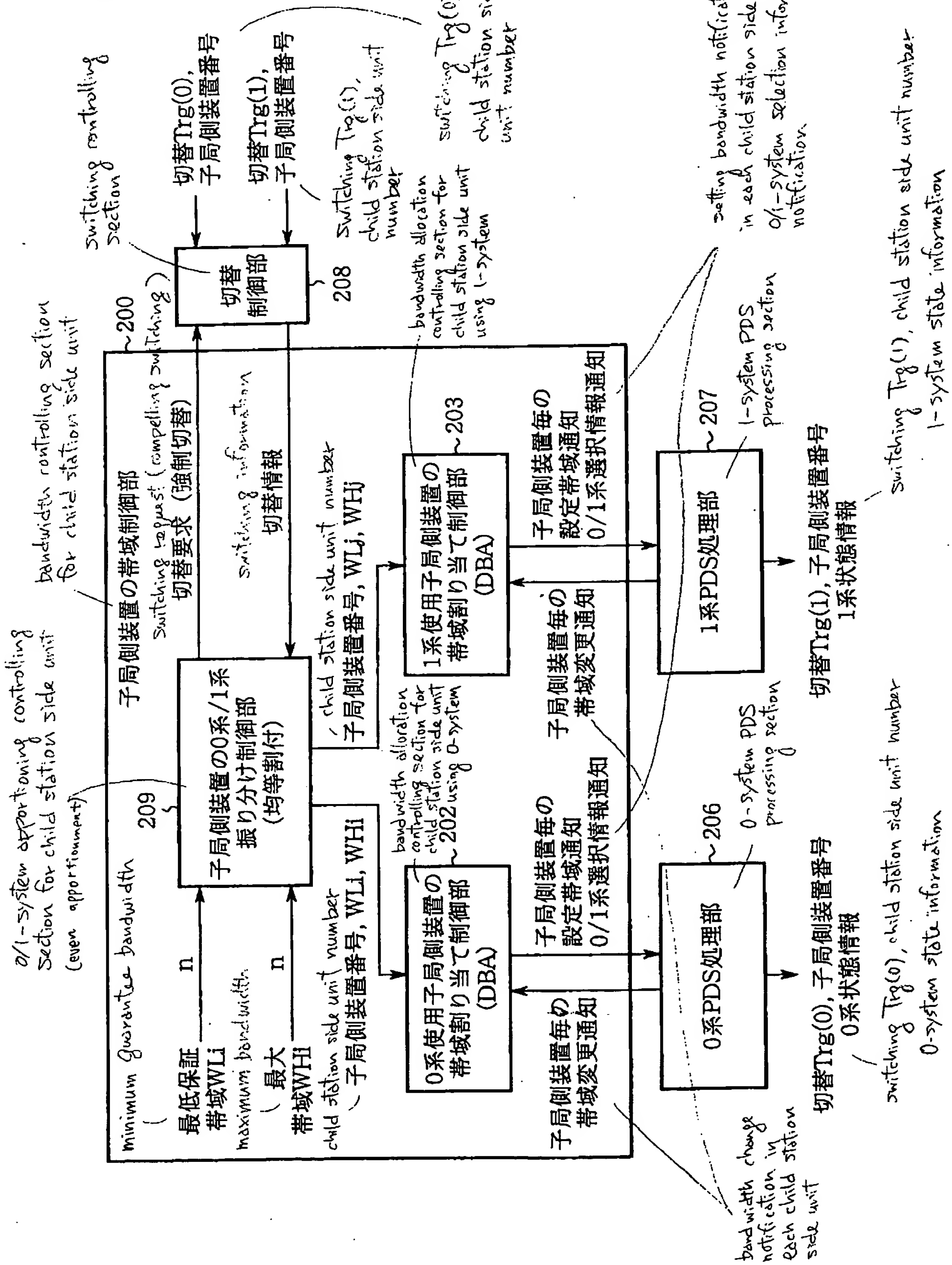


LIM : Line Interface Modue

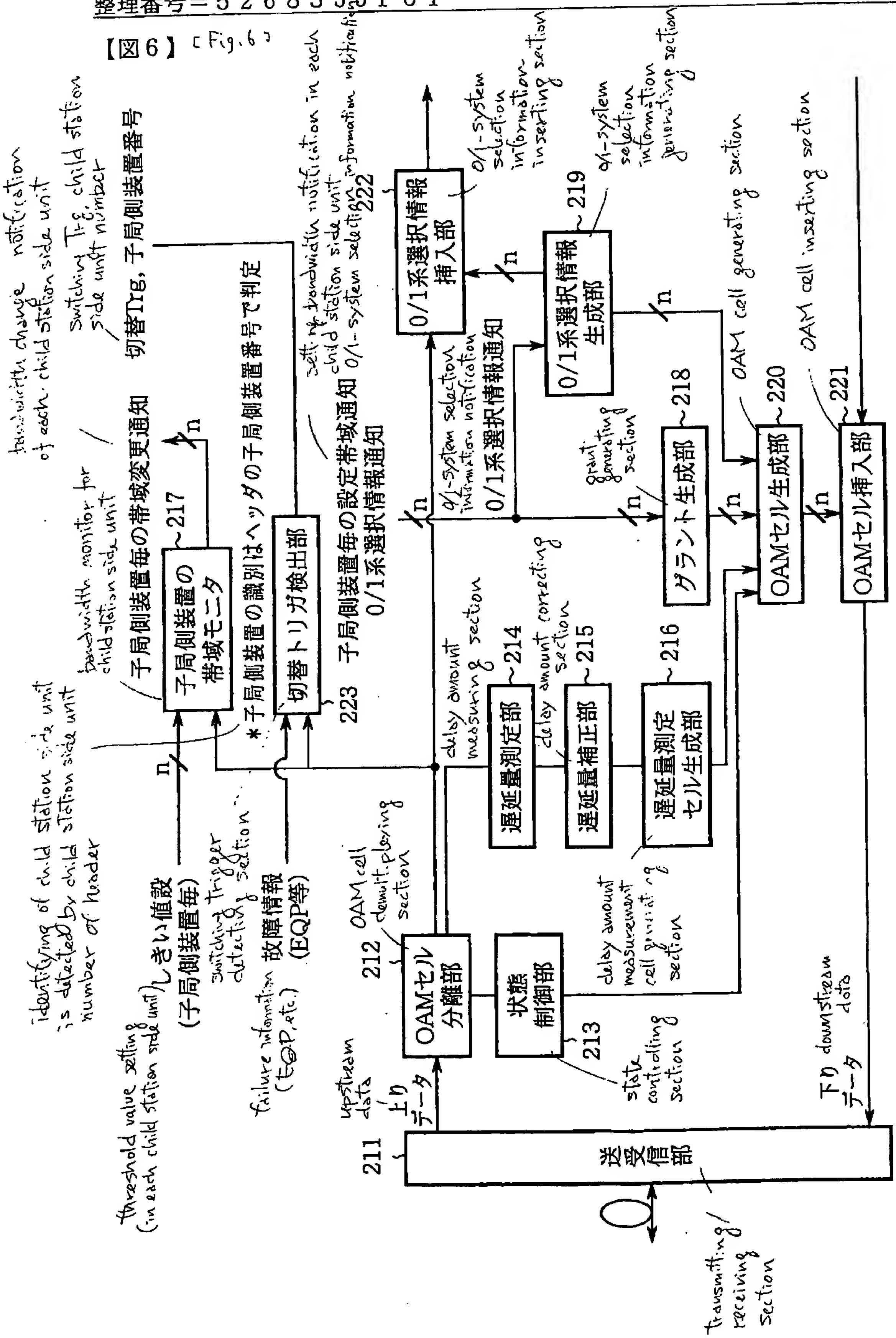
n：子局側装置のLIMの収容数 number of LIM of child station side unit

方路設定部：入力信号を2つの出力ポートのどちらかに接続 route setting section : input signal is connected to either of two output ports

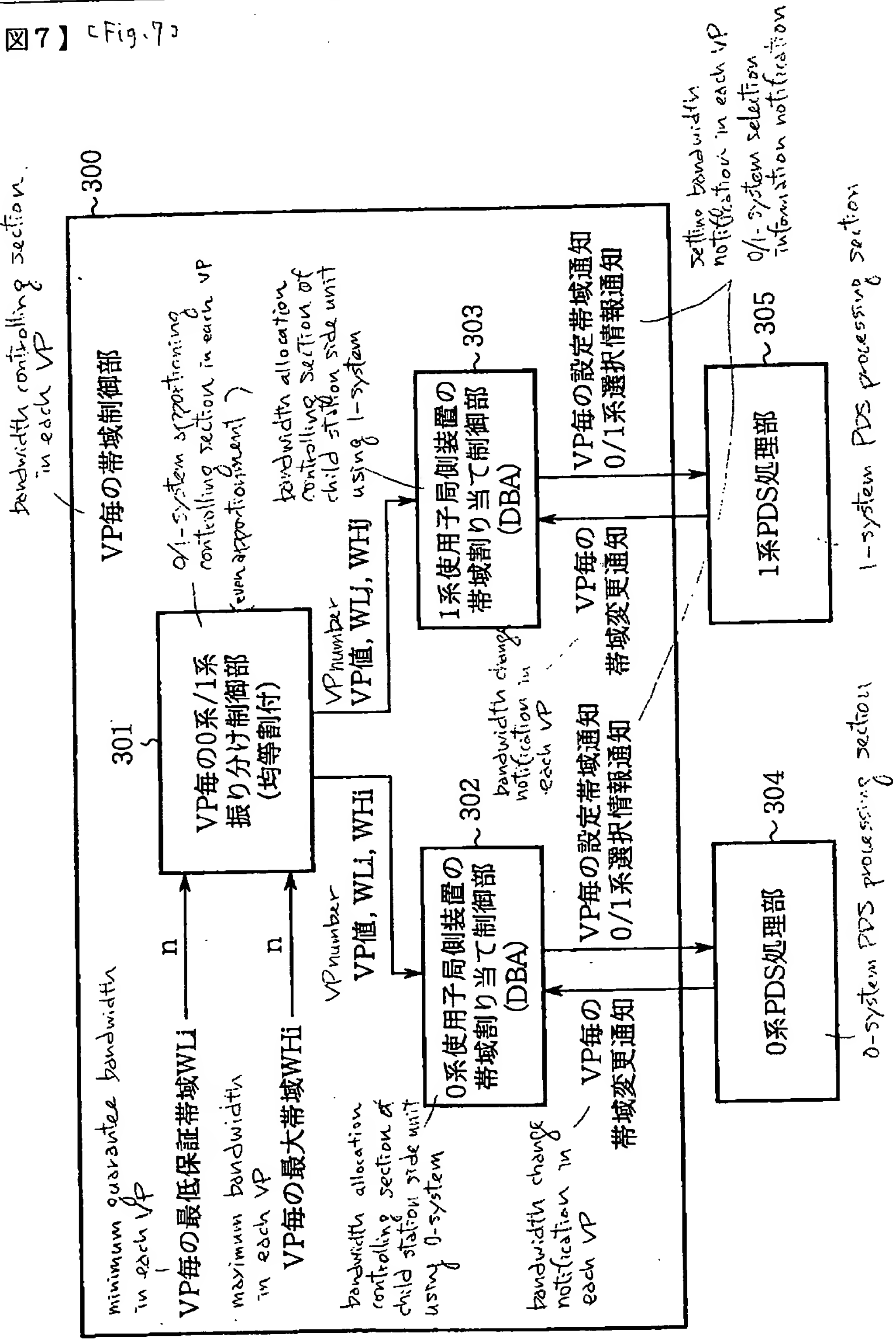
【図5】 [Fig. 5]


切替Trg(0), 子局側装置番号
切替Trg(1), 子局側装置番号
switching Trg(0), child station side unit number
switching Trg(1), child station side unit number
切替制御部
switching controlling section
208
200
子局側装置の帯域制御部
bandwidth controlling section for child station side unit
切替要求（強制切替）
switching request (compelling switching)
切替情報
switching information
子局側装置の0系/1系振り分け制御部（均等割付）
0/1-system apportioning controlling section for child station side unit (even apportionment)
209
最低保証帯域WLi
minimum guarantee bandwidth
最大帯域WHi
maximum bandwidth
n
n
子局側装置番号, WLi, WHi
child station side unit number
子局側装置番号, WLj, WHj
child station side unit number
0系使用子局側装置の帯域割り当て制御部（DBA）
bandwidth allocation controlling section for child station side unit using 0-system
202
1系使用子局側装置の帯域割り当て制御部（DBA）
bandwidth allocation controlling section for child station side unit using 1-system
203
子局側装置毎の設定帯域通知
0/1系選択情報通知
setting bandwidth notification in each child station side unit
0/1-system selection information notification
子局側装置毎の帯域変更通知
bandwidth change notification in each child station side unit
0系PDS処理部
0-system PDS processing section
206
1系PDS処理部
1-system PDS processing section
207
切替Trg(0), 子局側装置番号 0系状態情報
switching Trg(0), child station side unit number 0-system state information
切替Trg(1), 子局側装置番号 1系状態情報
switching Trg(1), child station side unit number 1-system state information

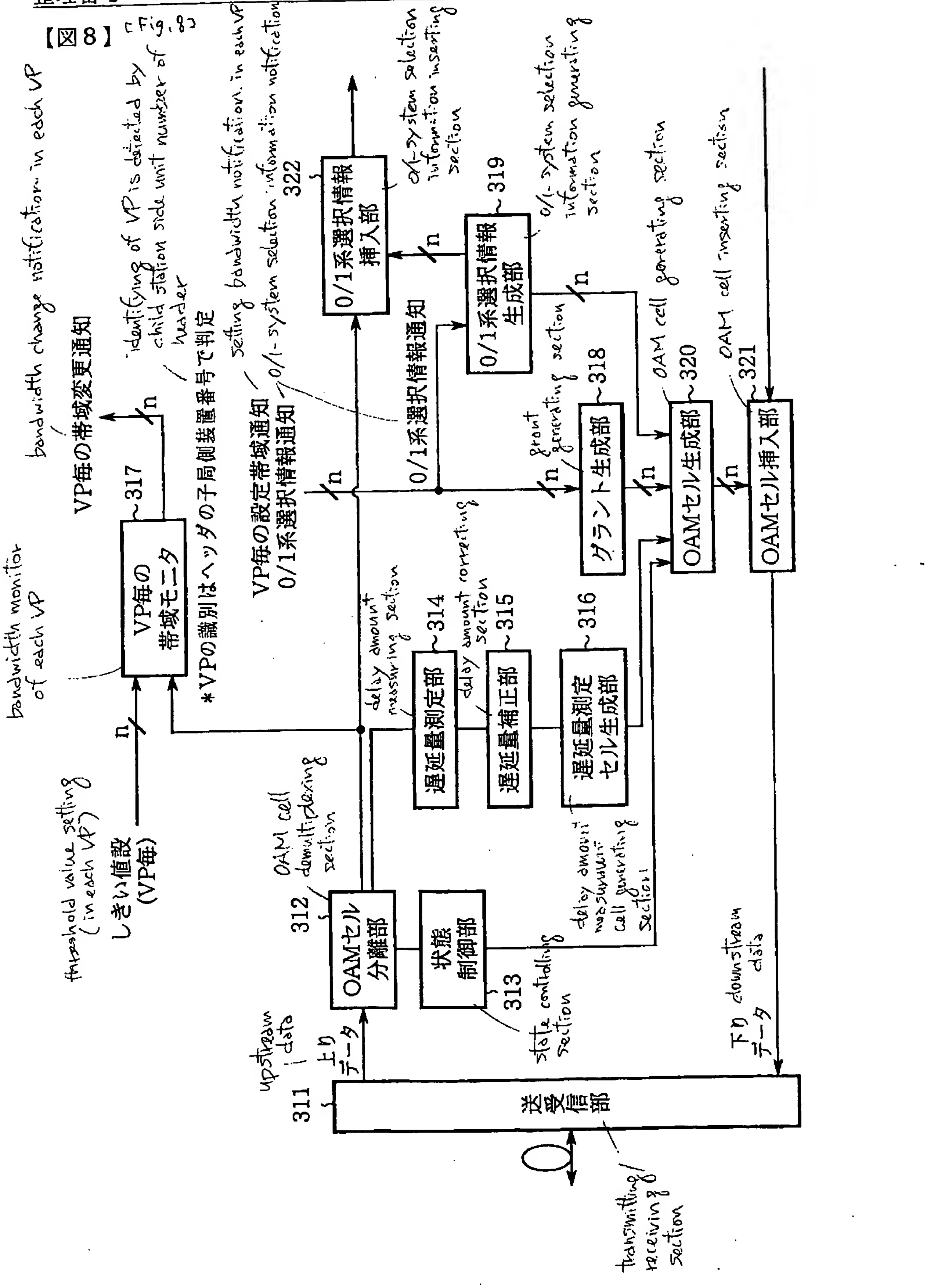
【図6】 [Fig.6]


しきい値設
(子局側装置毎)
threshold value setting (in each child station side unit)
故障情報
(EQP等)
failure information (EQP,etc.)
identifying of child station side unit is detected by child station side unit number of header
子局側装置の帯域モニタ
217
bandwidth monitor for child station side unit
子局側装置毎の帯域変更通知
bandwidth change notification of each child station side unit
切替Trg, 子局側装置番号
Switching Trg, child station side unit number
*子局側装置の識別はヘッダの子局側装置番号で判定
切替トリガ検出部
223
switching trigger detecting section
子局側装置毎の設定帯域通知
setting bandwidth notification in each child station side unit
0/1系選択情報通知
0/1-system selection information notification
211
送受信部
transmitting/receiving section
上りデータ
upstream data
212
OAMセル分離部
OAM cell demultiplexing section
状態制御部
213
state controlling section
遅延量測定部
214
delay amount measuring section
遅延量補正部
215
delay amount correcting section
遅延量測定セル生成部
216
delay amount measurement cell generating section
0/1系選択情報挿入部
222
0/1-system selection information inserting section
0/1系選択情報生成部
219
0/1-system selection information generating section
グラント生成部
218
grant generating section
OAMセル生成部
220
OAM cell generating section
OAMセル挿入部
221
OAM cell inserting section
下りデータ
downstream data
n

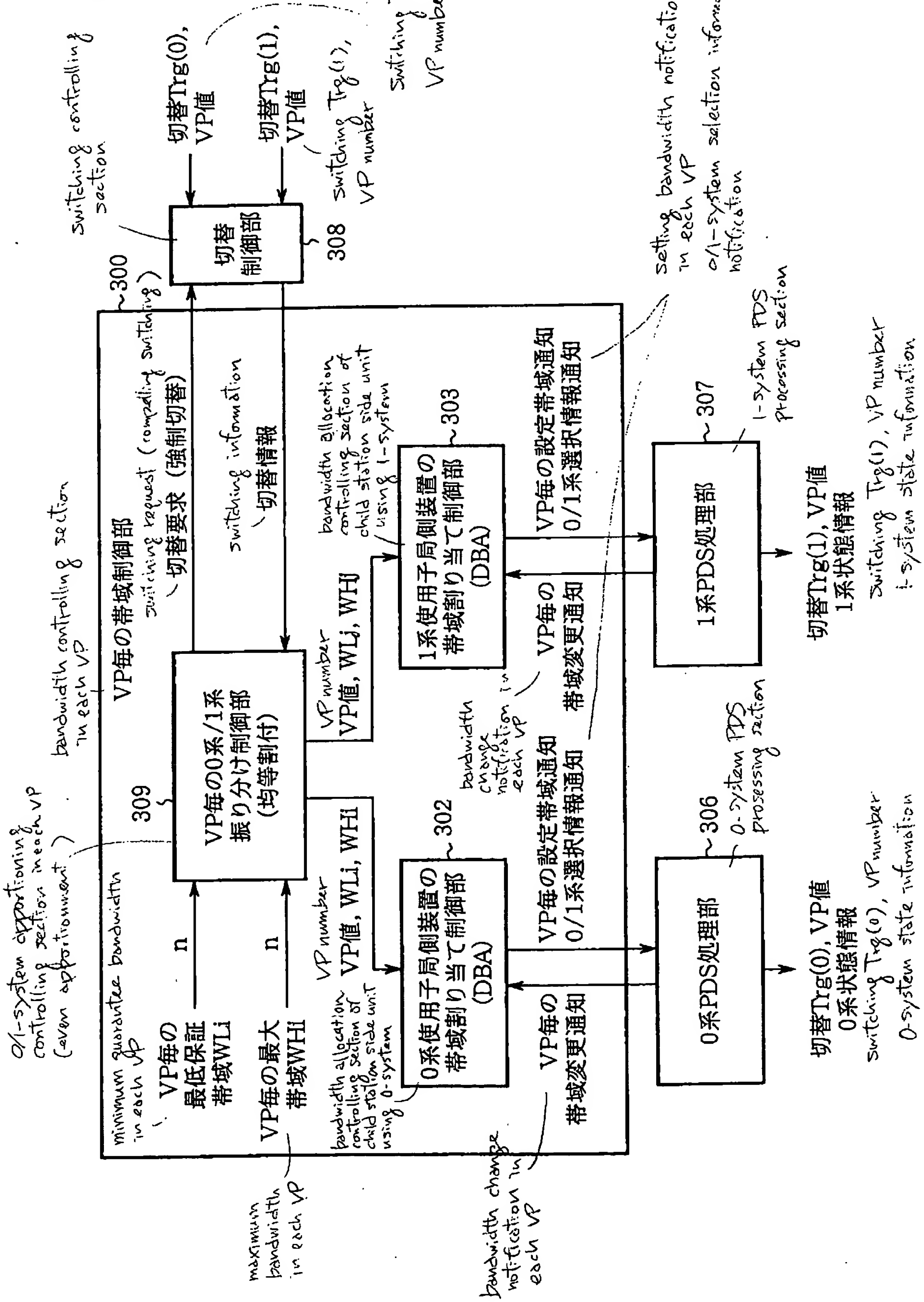
【図７】 [Fig.7]


300
VP毎の帯域制御部
bandwidth controlling section in each VP
301
VP毎の0系/1系振り分け制御部(均等割付)
0/1-system apportioning controlling section in each VP (even apportionment)
302
0系使用子局側装置の帯域割り当て制御部(DBA)
bandwidth allocation controlling section of child station side unit using 0-system
303
1系使用子局側装置の帯域割り当て制御部(DBA)
bandwidth allocation controlling section of child station side unit using 1-system
304
0系PDS処理部
0-system PDS processing section
305
1系PDS処理部
1-system PDS processing section
VP値, WLi, WHi
VP number
VP毎の設定帯域通知
setting bandwidth notification in each VP
0/1系選択情報通知
0/1-system selection information notification
VP毎の帯域変更通知
bandwidth change notification in each VP
VP毎の最低保証帯域WLi
minimum guarantee bandwidth in each VP
VP毎の最大帯域WHi
maximum bandwidth in each VP
n

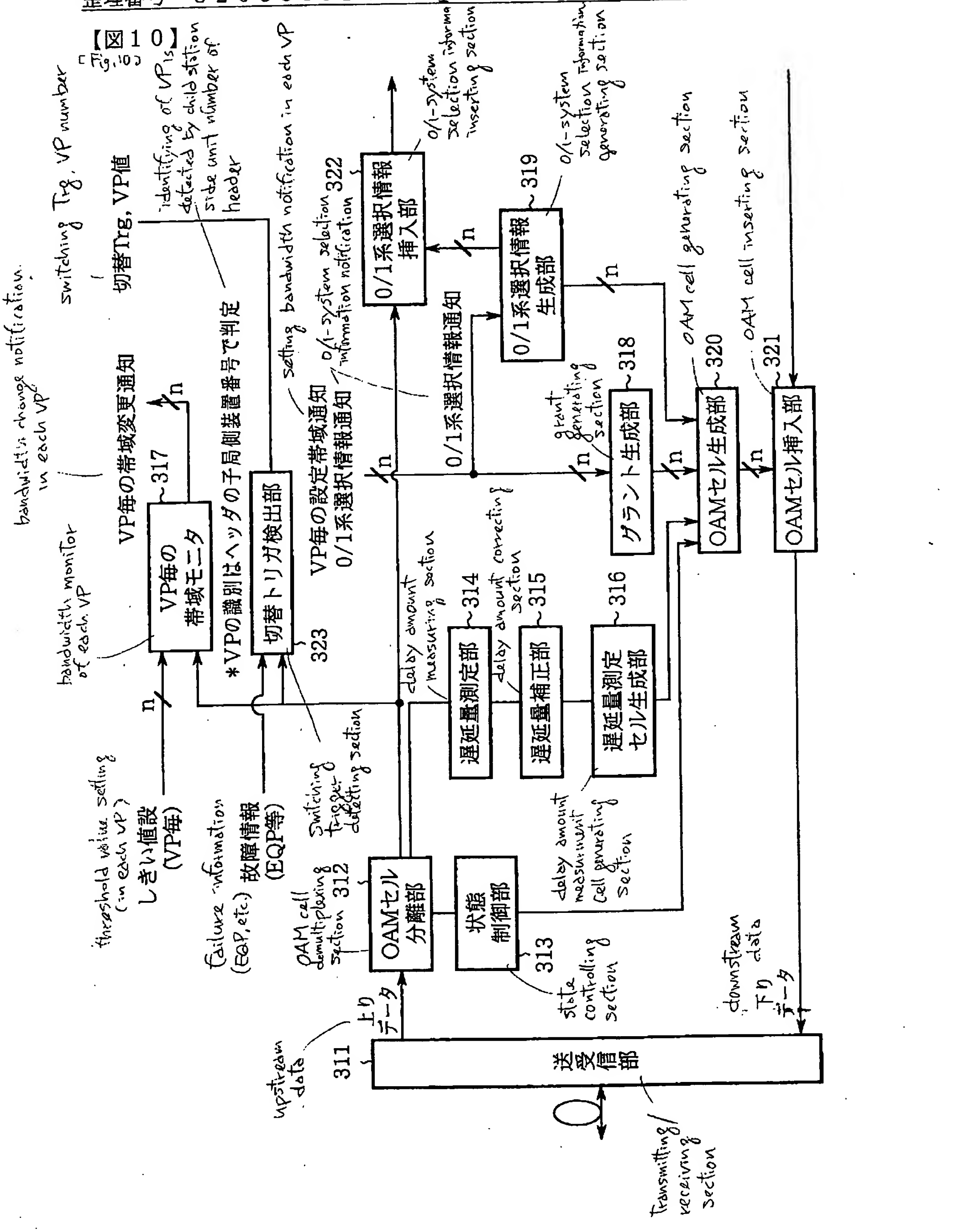
【図８】 [Fig.8]


しきい値設
(VP毎)
threshold value setting (in each VP)
VP毎の
帯域モニタ
bandwidth monitor of each VP
317
VP毎の帯域変更通知
bandwidth change notification in each VP
＊VPの識別はヘッダの子局側装置番号で判定
identifying of VP is detected by child station side unit number of header
VP毎の設定帯域通知
setting bandwidth notification in each VP
0/1系選択情報通知
0/1-system selection information notification
322
0/1系選択情報
挿入部
0/1-system selection information inserting section
319
0/1系選択情報
生成部
0/1-system selection information generating section
318
グラント生成部
grant generating section
320
OAMセル生成部
OAM cell generating section
321
OAMセル挿入部
OAM cell inserting section
314
遅延量測定部
delay amount measuring section
315
遅延量補正部
delay amount correcting section
316
遅延量測定
セル生成部
delay amount measuring cell generating section
312
OAMセル
分離部
OAM cell demultiplexing section
313
状態
制御部
state controlling section
上り
データ
upstream data
下り
データ
downstream data
311
送受信部
transmitting/receiving section
n

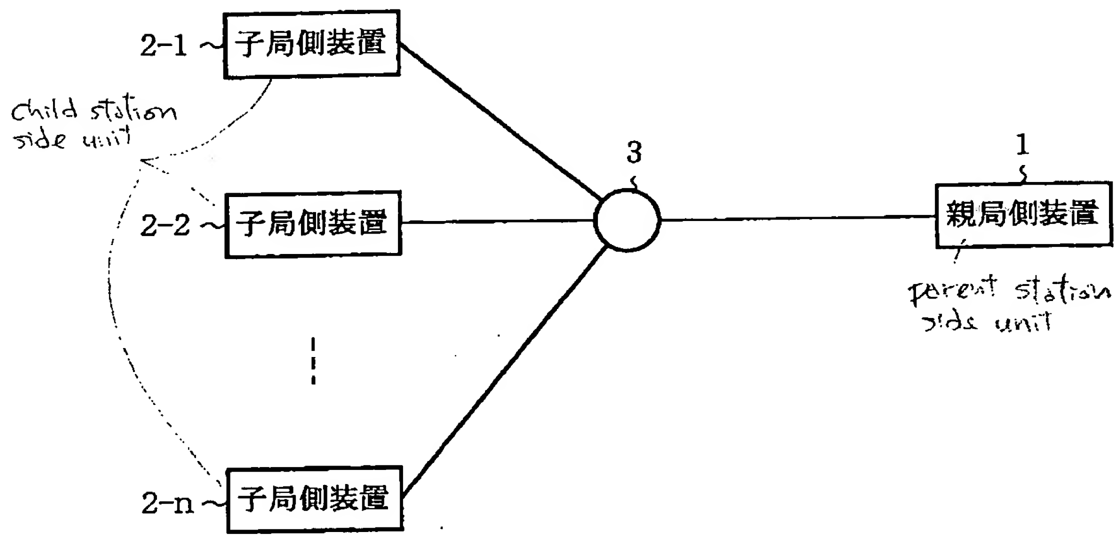
【図９】[Fig.9]


切替Trg(0), VP値
切替Trg(1), VP値
Switching Trg(0), VP number
Switching Trg(1), VP number
切替制御部
switching controlling section
308
300
VP毎の帯域制御部
bandwidth controlling section in each VP
切替要求（強制切替）
switching request (compelling switching)
切替情報
switching information
VP毎の0系/1系振り分け制御部（均等割付）
0/1-system apportioning controlling section in each VP (even apportionment)
309
VP毎の最低保証帯域WLi
minimum guarantee bandwidth in each VP
VP毎の最大帯域WHi
maximum bandwidth in each VP
n
n
VP値, WLi, WHi
VP number
1系使用子局側装置の帯域割り当て制御部（DBA）
bandwidth allocation controlling section of child station side unit using 1-system
303
0系使用子局側装置の帯域割り当て制御部（DBA）
bandwidth allocation controlling section of child station side unit using 0-system
302
VP毎の設定帯域通知
0/1系選択情報通知
setting bandwidth notification in each VP
0/1-system selection information notification
VP毎の帯域変更通知
bandwidth change notification in each VP
1系PDS処理部
1-system PDS processing section
307
0系PDS処理部
0-system PDS processing section
306
切替Trg(1), VP値
1系状態情報
Switching Trg(1), VP number
1-system state information
切替Trg(0), VP値
0系状態情報
Switching Trg(0), VP number
0-system state information

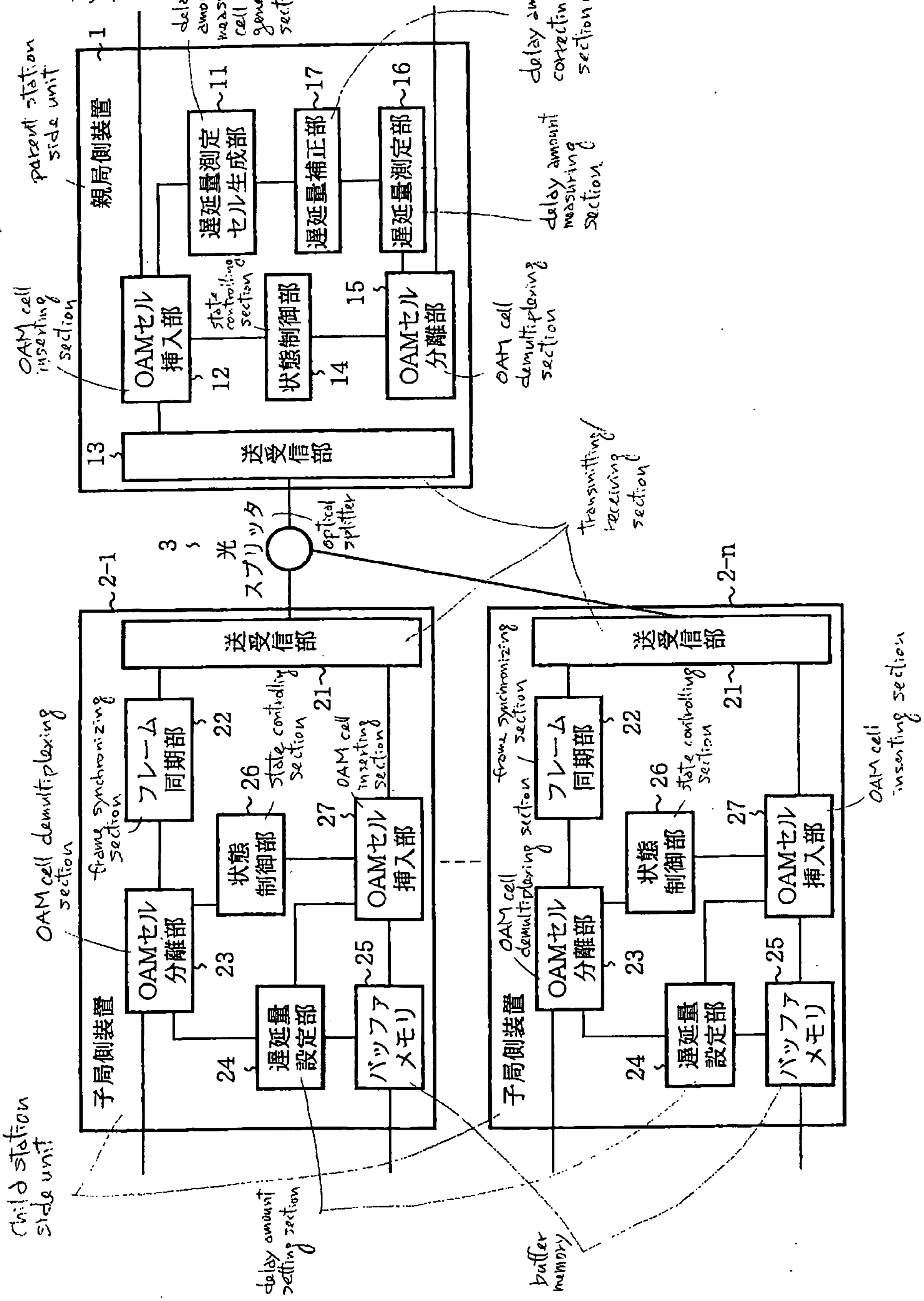
【図１０】
「Fig.10」


311
送受信部
Transmitting/receiving section
上りデータ
upstream data
下りデータ
downstream data
312
OAMセル分離部
OAM cell demultiplexing section
313
状態制御部
state controlling section
314
遅延量測定部
delay amount measuring section
315
遅延量補正部
delay amount correcting section
316
遅延量測定セル生成部
delay amount measurement cell generating section
317
VP毎の帯域モニタ
bandwidth monitor of each VP
VP毎の帯域変更通知
bandwidth change notification in each VP
318
グラント生成部
grant generating section
319
0/1系選択情報生成部
0/1-system selection information generating section
320
OAMセル生成部
OAM cell generating section
321
OAMセル挿入部
OAM cell inserting section
322
0/1系選択情報挿入部
0/1-system selection information inserting section
323
切替トリガ検出部
switching trigger detecting section
しきい値設定(VP毎)
threshold value setting (in each VP)
故障情報(EQP等)
failure information (EQP, etc.)
切替Trg, VP値
switching Trg, VP number
＊VPの識別はヘッダの子局側装置番号で判定
identifying of VP is detected by child station side unit number of header
VP毎の設定帯域通知
setting bandwidth notification in each VP
0/1系選択情報通知
0/1-system selection information notification
n

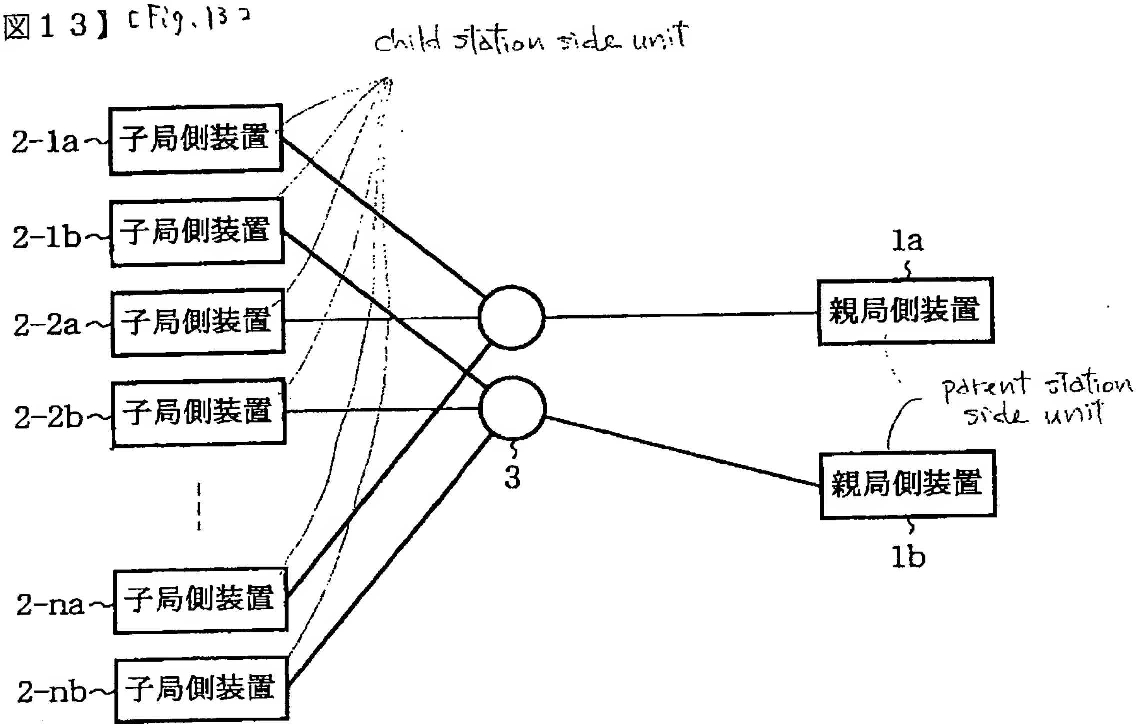
【図１１】 [Fig. 11]


2-1
子局側装置
child station side unit
3
1
2-2
子局側装置
親局側装置
parent station side unit
2-n
子局側装置

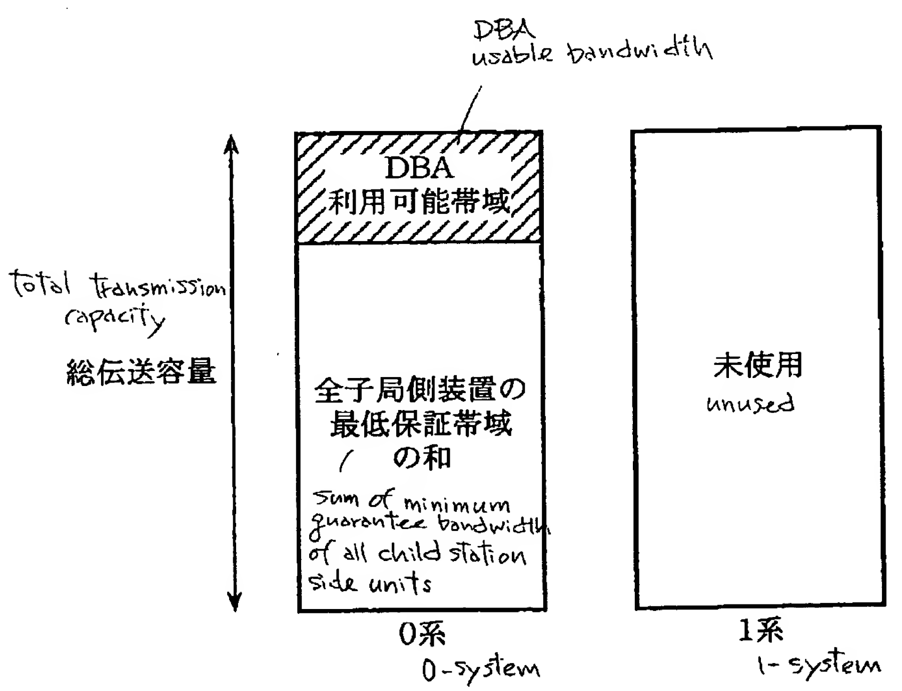
【図１２】
[Fig. 12]


親局側装置
parent station side unit
1
遅延量測定セル生成部
delay amount measurement cell generating section
11
遅延量補正部
delay amount correcting section
17
遅延量測定部
delay amount measuring section
16
OAMセル挿入部
OAM cell inserting section
12
状態制御部
state controlling section
14
OAMセル分離部
OAM cell demultiplexing section
15
送受信部
transmitting/receiving section
13
光スプリッタ
optical splitter
3
2-1
2-n
子局側装置
child station side unit
送受信部
21
フレーム同期部
frame synchronizing section
22
状態制御部
state controlling section
26
OAMセル挿入部
OAM cell inserting section
27
OAMセル分離部
OAM cell demultiplexing section
23
遅延量設定部
delay amount setting section
24
バッファメモリ
buffer memory
25

【図１３】 [Fig.13]



【図１４】 [Fig.14]



[NAME OF THE DOCUMENT]

ABSTRACT OF THE DISCLOSURE

[ABSTRACT]

[PROBLEM]

The maximum bandwidth available by DBA is equal to the total transmission bandwidth of working side minus the sum total of the minimum guarantee bandwidths of the child station side units, and There is a problem that it cannot secure a large DBA usable bandwidth, when congestion of bandwidth increase takes place among the plurality of child station side units.

[SOLVING MEANS]

A plurality of child station side units are apportioned to the first optical network and the second optical network, and a predetermined transmission bandwidth is allocated to each of the plurality of child station side units, and there is provided a bandwidth control means for accepting a bandwidth change of the transmission bandwidth.

[SELECTED DRAWING]

Fig. 1